Water Supply and Sanitation Department, Government of Maharashtra

Faecal Sludge Management in Rural Areas under SBM (G)

Training Manual

सृजन महाराष्ट्र – निर्मल महाराष्ट्र
पाणी व स्वच्छता सहाय्य संस्था

स्वच्छ भारत
एक कदम स्वच्छता की ओर

UNITED Nations Children's Fund (UNICEF), August 2018

Please contact:

UNICEF Office for Maharashtra, B-Wing, R2,
Technopolis Building, Ground Floor,
Mahakali Caves Road, Andheri (East),
Mumbai, Maharashtra, India- 400 093

Content:

Developed with Technical Support from UNICEF Maharashtra and PriMove, Pune.

Photo:

UNICEF, India and PriMove, Pune

Design:

Fountainhead India

Water Supply and Sanitation Department,
Government of Maharashtra

Faecal Sludge Management in Rural Areas under SBM (G)

Training Manual

Table of contents

Abbreviations v

Chapter 1: About training manual 1

Chapter 2: Important definitions 5

Chapter 3: Faecal sludge management 7

Chapter 4: Policy and legal framework for FSM 13

Chapter 5: Faecal sludge and septage management (FSSM) value chain 17

Chapter 6: Various technical options for containment of faecal sludge 21

Chapter 7: Various technical options for collection and transportation of faecal sludge 29

Chapter 8: Treatment technologies for faecal sludge management 35

Chapter 9: Planning, implementation and monitoring of FSM 41

Annex 1: 46

Annex 2: 49

List of references 50

Abbreviations

CSR	Corporate Social Responsibility
DWSM	District Water And Sanitation Mission.
FFC	Fourteenth Finance Commission
FGD	Focus Group Discussion
FSM	Faecal Sludge Management
FSSM	Faecal Sludge And Septage Management
FSTPs	Faecal Sludge Treatment Plant
MAPET	Manual Pit Emptying Technology
MAVIM	Mahila Arthik Vikas Mahamandal
MAWTS	Mirpur Agricultural Workshop And Training School
MoEF&CC	Ministry Of Environment, Forests And Climate Change
MoUD	Ministry Of Urban Development
MSRLM	Maharashtra State Rural Livelihood Mission
ODF	Open Defecation Free
OSSF	Other Onsite Sanitation Facilities
SBCM	Social Behavioural Change Management
SBM	Swachh Bharat Mission
SHGs	Self-Help Groups
SLRM	Solid Liquid Resource Management
STPs	Sewage Treatment Plant
TTFSM	Treatment Technologies For Faecal Sludge Management

CHAPTER 1

About training manual

1.1 Background

The central and state governments, along with various public and private sector organizations, development partners have been taking efforts to make India open defecation free. Various community driven missions like Nirmal Gram Puraskars, Sant Gadgebaba Gram Swachhata Abhiyan, etc. were implemented during early 2000s to create a movement for sanitation. The sector received much needed boost with introduction of Nirmal Bharat Abhiyan and Swachh Bharat Mission. Through Swachh Bharat Mission, the central government is aiming to make the entire country open-defecation-free (ODF) before 2nd October 2019.

In 2016, the government of Maharashtra declared its aim to achieve 100% elimination of open defecation by March 2018. For achieving the target, the state pioneered innovative approaches, strengthened institutional arrangements, ensured strong focus on behaviour change and the environment for learning as well as adapting new dimensions. The state has now been declared ODF as per the baseline survey of 2012. However, building toilets and creating infrastructure is just not enough to ensure improved sanitation and health conditions. The sustainable use of toilets and effective management of faecal sludge are critical challenges for sustaining the ODF status and achieving public health goals.

The toilets in rural areas are primarily of following types- twin pit, one pit, biogas and septic tank type. Effective waste management in all these types of toilets is critical for healthy environment. Faecal sludge management in case of two pit type latrines is safe since the excreta is decomposed naturally in the pits and there is an alternative pit for use when the waste is being converted into manure. However, effective waste management is required in case of single pit latrines and septic tank type latrines. Once the single pits are filled up, the user has no option but to revert back to open defecation. In septic tanks, many times decomposition of waste does not take place and the waste needs to be pumped out and treated. The septic tanks are generally not constructed with required retention period in rural areas of Maharashtra, which leads to inefficient decomposition leading to serious health hazards. Also, there is no proper mechanism and awareness regarding management of septage from institutional and community toilets. Thus, creation of effective systems for management of faecal sludge is crucial.

Presently, there is inadequate awareness and knowledge about faecal sludge management among government functionaries and community. This manual has been developed jointly by Water Supply and Sanitation Department, GoM, UNICEF, Mumbai and PriMove, Pune for providing information and guidance about faecal sludge management in rural areas.

1.2 Content of the manual

The manual presents important definitions regarding Faecal Sludge Management (FSM) followed by the status of sanitation in the state, major opportunities and challenges regarding FSM, legal provisions, etc., are presented in the next section. Subsequently, various technology options for all components in the FSM service value chain are described in the later sections. The last section of the manual discusses the methodology for planning, implementation and monitoring of FSM.

1.3 Target users of this manual

The manual is targeted for use by DWSM experts, BRCs, state and district KRCs, PRI functionaries at various levels, officials and officers, SHGs contributing to ODF status achievement, villagers, various organizations working in the field of sanitation and facilitators of FSM.

1.4 How to use this manual

This manual intends to appraise the participants about technical information, legal provisions, service value chain of FSM, relevant technologies of containment, collection, transportation and methodology for planning, implementation and monitoring of FSM. For effective use of this manual, the reader needs to read, understand and internalize the subject matter.

CHAPTER 2

Important definitions

This section presents important definitions regarding faecal sludge management which need to be understood before proceeding to the next chapters.

2.1 Faecal sludge

Faecal Sludge (FS) is the material that is collected from pit latrines, septic tanks or other onsite sanitation facilities (OSSF) and not transported through a sewer. Faecal Sludge is raw or partially digested, slurry or semisolid in nature. It contains various harmful physical, biological, chemical components which need to be treated properly.

2.2 "On-site sanitation" (OSS) system

Places where underground sewage systems are not possible, containment structures like septic tank or twin-pit are used to collect the human waste. Since these containment structures are located near to the toilets, these are called on-site sanitation systems. Twin pit and septic tanks both are examples of on-site sanitation systems.

2.3 Septage management and faecal sludge management

Septage Management refers to the comprehensive program for managing septic tanks and the procedures for desludging, transporting, treating and disposing of septic tank content. Faecal Sludge Management is the collection, transport, and treatment of faecal sludge from pit latrines, septic tanks or other onsite sanitation systems.

2.4 Other important definitions

BLACK WATER
A mixture of urine, faeces and flush water along with anal cleansing water, and/or dry cleansing materials.

GREY WATER
The total volume of water generated from washing food, clothes and dishware, as well as from bathing, but not from toilets.

FAECES
Refers to (semi-solid) excrements devoid of urine or water

SEPTAGE
Refers to the solid or settled contents of septic tanks;

SEWAGE
General term given to the mixture of water and excreta (urine and faeces).

SEWER
An open channel or closed pipe to convey sewage.

SEWERAGE
All the components of a system to collect, transport and treat sewage (including pipes, pumps, tanks etc.).

SLUDGE
Refers to the settled solid matter in semi-solid condition – it is usually a mixture of solids and water deposited at the bottom of septic tanks.

CHAPTER 3

Faecal sludge management

3.1 Background

Swachh Bharat Mission is being implemented effectively throughout the country, and as a result many states and districts are in the process of being declared as 'Open Defecation Free'. This movement will create necessary sanitation infrastructure in the nation. However, for its sustained use, focus should be on social behavioural change communication (SBCC) and technical appropriateness of sanitation facilities. Additionally, it is necessary to create capable systems for its operation and maintenance, generate entrepreneurship opportunities in sanitation, and also build necessary systemic and human capacities.

Faecal Sludge Management is an important component of O&M of sanitation facilities. Following section presents the toilet typology wise nature of FSM requirements-

Twin pit latrines- In case of twin pit latrines, the liquid and gases generally infiltrates into the surrounding soil and solids are allowed to decompose through aerobic processes in the pit. Second pit is connected to the toilet when the first pit gets full. First pit is then closed till the waste decomposes and turns into manure. This decomposition process takes at least a year. These types of toilets do not need external faecal sludge management apart from pit emptying.

Single pit latrines- When the single pit gets filled up, it cannot be used till the waste is completely decomposed. The users have no option but to revert to open defecation in such cases. Thus, these toilets need to be converted into twin pits by digging a second pit and connecting it to the toilet by a junction chamber.

Septic tank type toilets- In case of septic tank type toilets, anaerobic bacterial environment develops in the tank which decomposes the waste discharged into the tank. The rate of accumulation of sludge is faster than the rate of decomposition. Therefore, the accumulated faecal sludge must be periodically removed for further management. The systems for management of septage are available in big cities. However, in case of rural areas or census towns, the septage is disposed of on open spaces or in water bodies. Considering the harmful impacts of such practices, appropriate systems for emptying, transportation and management of septage need to be developed.

3.2 FSM in rural and urban areas of Maharashtra

The nature of services available for faecal sludge management depends on the size of population, location and pattern of development. This section briefly describes the nature of FSM in rural and urban areas of Maharashtra.

Before we discuss the nature of FSM, let us first understand the definitions of various urban and rural entities as defined by the Census of India.

Rural area- Area which is different from urban area and the basic unit is a revenue village

Urban Agglomeration- An urban agglomeration is a continuous urban spread constituting a town and its adjoining outgrowths (OGs), or two or more physically contiguous towns together with or without outgrowths of such towns. An Urban Agglomeration must consist of at least a statutory town and its total population (i.e. all the constituents put together) should not be less than 20,000 as per the 2001 Census.

Statutory towns- All places with municipality, corporation, cantonment board or notified town area committee etc.

Census towns- Are the areas which are not statutorily notified and administered as a town, but nevertheless whose population has attained urban characteristics has minimum population of 5000, at least 75% of the male working population is engaged in non-agriculture pursuits and a density of population of at least 400 persons per sq. km. CTs are currently administered as rural areas.

Out Growths: A viable unit such as a village or part of a village contiguous to a statutory town and possess the urban features in terms of infrastructure and amenities such as pucca roads, electricity, taps, drainage system, educational institutions, post offices, medical facilities, banks etc.

3.2.1 Status of FSM in Out Growths/ urban area/ statutory towns

In case of urban areas and statutory towns, FSM system exists where sewer lines are created to transport the sewage from latrines. The sewage is collected at a Sewage Treatment Plant (STP) and treated to form manure or a semi-solid waste or slurry, called sewage sludge. After treatment, sewage sludge is generally disposed of in landfills, dumped in water bodies or applied to land.

However, such systems are not available in all urban areas. In areas where sewer systems are not available, untreated sewage is discharged in river bodies or in open. Similarly, urban settlements which are not connected to the sewer network need to pump the sewer with help of a vacuum truck. In some of these areas, on-site treatment is done through technologies like tiger biofilter, baffle reactor, DEWAT, etc.

3.2.2 FSM in rural areas, census towns and growth centres

According to Census 2011, out of the total 11.2 core population of Maharashtra, the size of rural population is 6.2 crore which constitutes 55% of the total population. On the other hand, the rural areas are characterised by rapid increase of Census Towns (CTs) in the recent years. Between 2001 and 2011, CTs in the state have grown from 127 to 279. This situation clearly highlights the need for FSM in these areas.

So far, about 1.10 crore toilets have been constructed in rural Maharashtra which include twin pit types, single pit types, biogas and septic tank types. In case of

twin pit latrines, no external faecal sludge management is required, whereas on site management of faecal sludge is possible in single pit latrines if a second pit is dug. However, septage management is a critical issue in these areas.

Though the data on typology of toilets is not yet available, it is estimated that approximately 20% (about 22 lakh toilets) of rural toilets are of septic tank types. In most of the census towns and growth centres, there are no sewer lines which connect the toilets to Sewage Treatment Plants (STPs) in the nearby area. Maximum septic tanks are accumulated in this area. The septage generated by the septic tanks in these areas are collected and disposed either in water bodies or open land.

As per a recent study by SIGMA Foundation, 9.3% of the surveyed HHs from Nagar Panchayats had no drainage system to carry the waste water while 43.3% of the ULBs had kuccha drains. Stagnant water was found near the drinking water source in 51.2% of the ULBs, while water spillage on the public road was seen in 45.8% of the ULBs. Moreover, grey water was found to be overflowing within 42.3% of the HH premises[1].

In rural areas, management of liquid waste villages is not satisfactory. According to a recent assessment of status of ODF and related factors done by UNICEF and SIGMA foundation, 23.4% HHs had no drain to carry the liquid waste. Only in 1.6% HHs there were soak pits and in another 9.6% HHs there was pucca drain and the water was found flowing smoothly. In another 54.2% HHs though there was pucca drain but the same was found chocked and liquid waste remained stagnant. Further, grey water was seen to overflow within 9.3% of the HH premises.[2]

Therefore, Faecal Sludge Management interventions, including setting up of new systems as well as expansion, strengthening and upgrading of existing systems is necessary in rural areas of the state.

3.3 Need for FSM

Proper management of accumulated faecal sludge in rural areas poses a challenge with no formal mechanism in place for its treatment and management. Inefficient treatment of faecal sludge is harmful for human health and the environment. In case of twin pit latrines, though the waste is decomposed on site, shifting to the second pit and emptying the used pit needs to be done on time. Single pit latrines need to be converted in two pit latrines or some alternative technology needs to be thought of.

Considering the large number of septic tank type toilets and their technically incorrect construction; systems for cleaning and desludging of septic tanks are necessary. Effective system for desludging of septic tanks is important for sustained use of toilets and attaining the goal of complete sanitation in the state.

---

1 A report on Status Of ODF Sustainability In The Nagar Panchayats Of Maharashtra by SIGMA Foundation

2 an occasional report on ODF Sustainability and Water for Sanitation in Maharashtra prepared by SIGMA Foundation with Support of UNICEF, Maharashtra

3.4 Employment/ entrepreneurship opportunities in FSM

As mentioned above, there are 1.10 crore toilets constructed in rural Maharashtra, most of which are single or twin pits. In case of such toilets, there is a need for service providers for pit emptying or construction of second pit. Service providers for these services may be empaneled/ procured.

There are approximately 22 lakh septic toilets in the state. Considering the storage capacity of the septic tanks, they need to be desludged in 3-5 years. Keeping this in mind, it can be concluded that 4.40 lakh toilets will require cleaning every year, amounting to desludging of 1467 septic tanks per day. This means, in each of the 34 district of the state, around 43 toilets will need desludging per day. On an average 2 trips are made for cleaning one septic tank and around 6 trips are possible in a day. Required number of desludging tankers needs to be made available in every district based on the number of septic tanks. In the beginning, FSM services may be set up at cluster or block level. This clearly depicts that there is a wide scope for generating employment/ entrepreneurship opportunities in FSM for SHGs, unemployed youths, service providers, NGOs, etc.

In addition to this, involvement of private sector may be sought for desludging septic tanks. Efforts can be made for funding equipped vehicles or setting up of treatment plants. Desludging may be done by private contractors as per demand or through a sequential desludging of septic tank as per exhaustive lists. Appropriate fees may be changed from the users for desludging.

3.5 Challenges in FSM

Following are the key challenges for effective FSM in rural Maharashtra –

Emptying the soak pit and use of manure: There is a lack of awareness in rural areas regarding the process and need of emptying the filled pits, and use of manure from the pit. This generally results in restricted use of toilets (due to fear of pits filling fast).

Digging and connecting second pit to single pit latrines: Many single pit latrines have been constructed in rural areas, which are experiencing problems of pit filling up. Converting these single pit latrines into twin pit latrines and connecting the second pit to the existing latrines (which do not have a junction chamber) is a challenge. Construction of second pit is not possible in many cases due to space constraints. There is a fear of users reverting to open defecation after the pit gets filled up.

No / Limited access to tanks: Septic tanks are often placed under toilets, or they are sealed, or cemented over which makes it difficult to access them for cleaning/ emptying which dis-incentivizes their frequent cleaning. The desludging vehicle can desludge from maximum of 70 meters distance. Access roads to the rural toilets especially in the highly dense habitations are also an issue.

Inappropriate tank size and design: The government has released guidelines for technically correct construction of septic tanks. Yet, septic tanks connected to individual toilets are often not of proper size due to lack of awareness about the design norms among construction contractors and masons. As a result, the excreta does not get

properly decomposed and hence the tank gets filled early. This leads to households going for emptying services quickly, making it costly and environment polluting.

Management of septage: The septage from septic tanks is generally discharged in open or in canals *(nallas).* It is harmful environmentally and also for human health. The septage outlet needs to be discharged in a soak pit for its management. Financial support for this can be sought from 14th Finance Commission funds and MREGS funds.

Lack of infrastructure, and a regulated schedule for cleaning: Local bodies often face financial and personnel constraints in providing service to households- for example, insufficient suction emptier trucks, trained human resource, safety equipment, etc. to ensure regular cleaning/ emptying of septic tanks.

Treatment and Disposal: Typically, census towns and rural areas have no funds for the construction of FSTPs, STPs, and also there is no clear mandate which defines the responsibility of local authorities with regard to establishment of FSM service chain. Entire sewage is mostly dumped without treatment into the rivers, while untreated sludge and septage is disposed of in a dumping ground or available water body. In peri urban areas, the septage is disposed many times in the urban sewer systems, putting additional load on the urban systems.

Poor and Limited Awareness: Faecal Sludge and septage management has been accorded low priority among people and implementers and there is poor awareness about its inherent linkages with public health.

To sum up, management of faecal sludge in an environment friendly manner is necessary for attaining the goals of Swachh Bharat Mission. Creation and strengthening of facilities for transport and treatment of sludge is crucial, particularly for rural areas in the state. The central government has taken a step ahead in terms of policy and laws for FSM in urban areas in the country. The subsequent section of this manual describes the policy and legal framework for FSM. However, application of these laws or formation of laws for rural areas will need to be deliberated further.

CHAPTER 4

Policy and legal framework for FSM

4.1 Introduction

The central government has issued 'National Policy on Faecal Sludge and Septage Management'. However this is geared more towards the urban landscape. At present there is an absence of a National policy for faecal sludge management for rural areas. The urban policy can provide guidance and a framework for preparing the policy on FSM in rural areas. Study of the legal framework regarding FSM is also crucial for decision making which abides to the laws and acts of the state. Following section presents the urban policies and laws regarding FSM.

4.2 Urban policies on FSM

The National Urban Sanitation Policy (NUSP) of 2008 brought a paradigm shift from 'conventional centralized sewerage network' approach of urban sanitation to a more holistic approach. Few states (Tamil Nadu and Gujarat (2014), Delhi (2015), Odisha (2016) and Maharashtra (2016)) have developed their septage management guidelines. Apart from that, Ministry of Urban Development (MoUD) has recently released a primer on faecal sludge and septage management (FSSM) as well as a Rapid Assessment Tool to estimate the budget needs for FSSM.

Study of the urban policies will help in planning, selection of technology options and implementation of FSM in rural areas.

4.3 Relevant Acts

4.3.1 Environment laws

The environment laws include the Water (Prevention and Control of Pollution) Act, 1974 (the "Water Act") and the Environment (Protection) Act, 1986 (the "Environment Act"). Taken together, the implication of the environment laws is that:

(1) Discharge of any solid, liquid or other matter into water bodies and on land is restricted, and requires specific prior approval; and

(2) Depending on the type of discharge, and whether the discharge is on land or in water bodies, permissible standards are prescribed.

4.3.2 Solid waste management rules 2016

Rules regarding solid waste management have been notified by the Union Ministry of Environment, Forests and Climate Change (MoEF&CC) wherein few activities for solid waste management have been made mandatory. As per the rules, septage and faecal sludge management is necessary for controlling water, land and air pollution. Rules have been finalized for use of manures and landfills. Similarly, consideration to Building Code of India issued by Bureau of Indian Standardis mandatory while preparing policies for septage and faecal sludge management.

4.3.3 The Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993

The 1993 act was supplemented by 'The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013 (the 2013 Act)'. Taken together, the two laws prohibit various activities that involve manual handling of human excreta (defined as "manual scavenging"), and lay down conditions and safety standards for activities defined as "hazardous cleaning". The 2013 Act also requires conversion of insanitary latrines into sanitary latrines within a period stipulated by the local authority.

4.3.4 Panchayat Act

In terms of Constitutional allocation of powers and functions, the State Government has legislative and functional power over "public health and sanitation". The Fourteenth Finance Commission (FFC) identified "core functions" of PRIs, which include "sanitation, solid waste management and drainage".

The PRIs have the primary responsibility of rural sanitation management. The provisions of Panchayat act show that PRIs may already have the legal mandate to provide for most FSM related activities. However if there are areas/activities for which there are no legal provisions, they can be formulated by the state government.

Following activities may be taken up by the PRIs for FSM-

(i) Survey insanitary latrines, and monitor the setting up of on-site containment structures,

(ii) Carry out mandatory 'scheduled desludging', and monitor regular and periodic desludging,

(iii) Enforce a licensing and monitoring regimen for septage transport services.

(iv) Take up the responsibility of setting up faecal sludge treatment systems.

(v) Effective monitoring of the faecal sludge management systems

CHAPTER 5

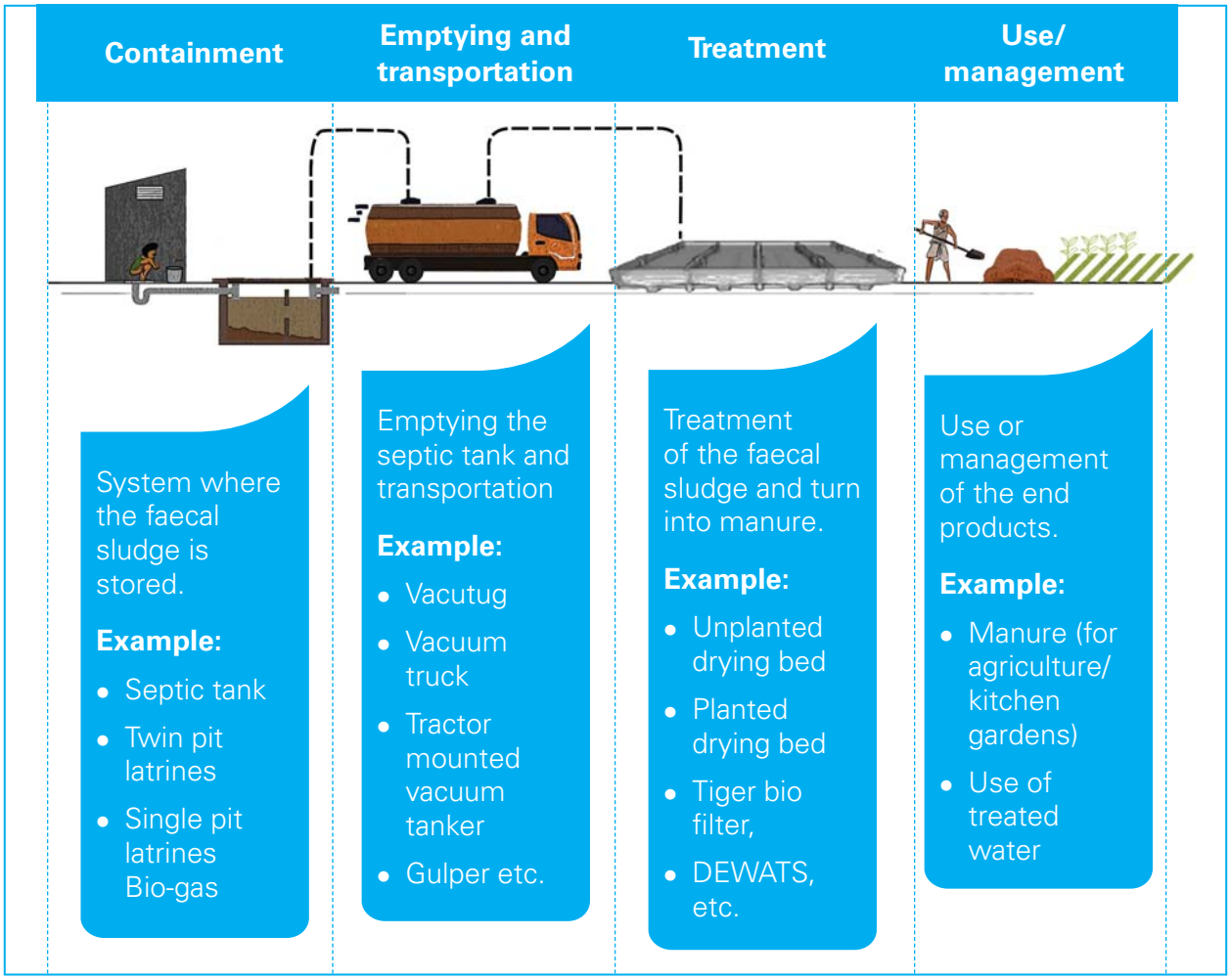
Faecal sludge and septage management (FSSM) value chain

5.1 Introduction

For efficient Faecal Sludge management and Septage Management, the reader needs to understand the entire FSSM Value Chain. The Service Value Chain includes safe containment of sludge, safe emptying and transportation; treatment and disposal/ reuse of Faecal Sludge and Septage (refer the diagram below). Each of these Value Chain components needs to be addressed properly to prevent health and environmental impacts in rural areas due to indiscriminate disposal of hazardous faecal waste. An overview of treatment technologies, together with their treatment objectives and functionality, are included in detail in this section.

5.1.1 System for safe containment of the faecal sludge

Promoting an appropriate and area-specific containment technology is vital, for which the CPHEEO norms should be followed. In rural areas of Maharashtra, twin pit latrines and septic tank type latrines are predominant. Few points need to be taken care of while constructing these latrines. In case of single or two pit latrines, the location of the pit should not be nearer to the water source or built on areas having higher ground water tables. Technically correct construction is crucial in all types of toilets. Inappropriate construction of septic tanks can lead to leakages in the tank, limited or



no access to tanks, chocking up of the toilet, or inappropriate treatment of the waste, etc. Next section of this manual elaborates the technology options for containment of faecal sludge and related operation and maintenance requirements.

5.1.2 Safe emptying and transportation

A septic tank is a combined sedimentation and digestion tank where settleable solids settle down to the bottom, accompanied by anaerobic digestion of settled solids (sludge) and liquid, resulting in reasonable reduction in the volume of sludge, reduction in biodegradable organic matter and release of gases. A substantial portion of solids escape with the effluent whenever a septic tank is not desludged for a longer period, i.e., more than the design period. Therefore, the septic tanks need to be desludged by automatic or human operated technologies. It is very important to avoid any human contact directly with faecal sludge, and following the safety measures thoroughly. The common technologies for emptying and transportation are listed below and discussed in detail in the subsequent sections.

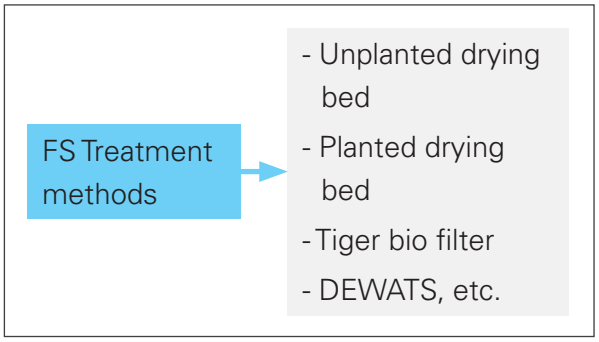
Technologies for emptying and transportation

- Vacutug
- Vacuum truck
- Tractor mounted vacuum tanker
- Gulper etc.

5.1.3 Treatment

In view of the characteristics faecal sludge,its efficient treatment is critical. Many technologies of faecal sludge treatment

like Sewage treatment plants (STP) are being used in urban areas. However, these technologies cannot be used in rural areas due to financial constraints and inadequate systems for its O&M. Few low cost and simpler technologies can be used in rural areas for treating the faecal sludge. Some of these treatments are mentioned below and described further in the subsequent sections.



5.1.4 Use/management

The end products of the FS treatment can be reused and managed well. The treated water from treatment plant can be used for agriculture and the compost can be used as manure for agriculture/ kitchen gardens. In big cities, the compost can be mixed with bio-degradable garbage to produce good quality manure through effective garbage disposal.

Considering the FSM Service Value Chain and its components, the selection of appropriate technology option for rural areas and its effective management is important. Various technology options for every component in the FSM value chain are described in detail in the next section.

CHAPTER 6

Various technical options for containment of faecal sludge

There are three important technologies for safe containment of the faecal sludge in rural areas-

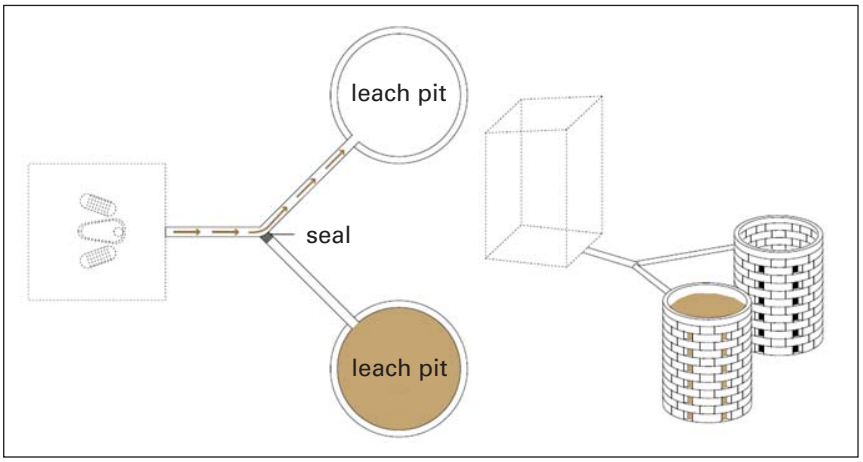
- Two pit pour flush toilet
- Septic Tank Toilet
- Biogas

It is imperative to construct technically appropriate toilets for proper management of faecal sludge. It is also important to understand the components, technical details, O&M requirements, etc. of each technology.

6.1 Two Pit toilet

6.1.1 Technical details

The faecal sludge is managed on site in this type of toilet construction. As per UNDP report, this technology is safe for human health and environmental balance. This technology uses less water (about 1 to 2 litres) and needs less space for construction. In this technology, excreta get dried and start decomposing in the pit due to bacterial reactions in the pit, between the excreta and soil. Gases generated during the decomposition process are also absorbed in the soil leading to odourless decomposition.



The water used for flushing and the leachate generated during decomposition process is absorbed in the soil surrounding the pit. The manure excavated from the pit is a good source of income. While constructing this type of toilet, care needs to be taken regarding the type of soil (absorbent soil is required) and pollution of ground water sources around the pits.

6.1.2 Construction of Leach Pits/ soak pits

Leach pits / soak pits are brick lining pits constructed below the ground surface. Bricks are arranged in a circular and honey comb manner to maintain 5-6 gaps of 2" in between each of the alternate brick layers. These gaps will allow percolation of excess water into the soil. Such gaps are not kept in the top 1 feet of the brick layer. No cement and/or concrete are applied at the bottom and on the sidewalls of the pit. After completing the construction of pit, each one is covered either with a moulded R.C.C. seal or any other local material that is used for flooring. For complete and safe decomposition of the excreta, two pits should be used alternately (after filling up of a pit). For an average family size of 5-7 people a single pit can last for more than 4 years; generating about 1 Cu Ft of compost per annum per person.

6.1.3 Limitations

- Since the leach pits are to be constructed underground, the area with rocky strata and areas where ground water table is high are not suitable for this technology.

- To construct this type of toilet, the selection of appropriate site is a key factor. While selecting a site, the location of nearby water sources and risk of chemical and bacteriological contamination of water should be considered on priority basis.
- Construction of two pits is necessary as construction of single pit may pose problems after getting completely filled.

6.1.4 What precautions need to be taken after the construction of toilet?

Following points should be ensured once the construction part is over or rather during the very last phase of construction.

- Sand, cement, debris etc. from all the toilet components should be cleaned off. Especially the pan, trap, the platform around the pan should be cleaned properly preferably by a wire brush and a jet of water.
- Junction chamber, drain pipes should be cleaned and there should not be a slightest obstacle.
- All the holes in the leach pit walls should be cleaned properly. Bottom of leach should be free from fallen mortar and, if necessary, it should be made permeable by light digging.
- One of the paths from junction chamber leading to leach pit should be plugged by a piece of brick and lean mortar.
- Cover the junction chamber with a suitable tile and seal the joints.
- Cover the leach pits with suitable covers and seal the joints between two halves of the cover as well as the one between cover and the leach pit wall.
- Don't keep the leach pit covers open to atmosphere; cover them with sufficient quantity of soil and compact it lightly.
- After completing the above mentioned steps, flush a bucketful of water into the pan. This will clear the entire path up to leach pit. Similarly the water seal trap will also get filled with required quantity of water.

6.1.5 Pit emptying and removal of manure

The Twin leach pit latrine is easy to construct, use and maintain. It saves water and can be used with less water as compared to other types of toilets. When leach pits gets filled, it can be emptied at household level by following the simple steps given here.

1. The mineralized manure in the pit needs to be emptied preferably in summer season. One should not empty it in the rainy season.

2. A family of 5 to 7 members, using twin leach pit latrine (Pit with three feet width and 3-4 feet depth) consistently for 6 to 7 years, shall result in one pit getting filled. This period may vary depending upon the soil type / strata, size of pit and the amount of water flushed during toilet use.

3. Whether a pit is full or not, can easily be found out from the toilet pan or the chamber by inspection by back flow or choking. If one pit gets filled, we need to

close the pipe connecting that pit from the chamber (If toilet constructed is of single pit, then the chamber and a second pit construction must be completed before emptying the filled pit), so that the faecal matter will not go to the pit which needs to be emptied.

4. Before disconnecting the pipe connecting the filled pit from the chamber, pipe of the second pit needs to be connected so that faecal matter will go in the other pit. Precaution should be taken while connecting the second pit to the chamber. The connection and slope of pipe should be as per technical requirements. Only then should the new pit be used.

5. Filled and closed pit should not be opened for a minimum of one year. During this period, water in the pit leaches out in the surrounding soil and the feacal matter is digested and converted as night soil manure. The time for conversion of feacal matter into decomposed night soil manure may vary depending upon the water absorption capacity of the local soil, the environment and size, shape and construction of the pit.

6. A filled Pit which is closed for a year for composting should be opened during the day time in sunlight. Condition of the material in the pit should be observed carefully. Absence of water, feacal matter looking like black or brown soil, 20 to 30% of upper part of pit without any feacal material and absence of any foul smell along with a cake like sump are common characteristics of fully composted night soil manure.

7 Before taking out the night soil manure it is necessary to confirm that feacal matter is completely decomposed and there is no dampness in the decomposed matter. (This can be easily checked with the help of a hollow iron rod. This rod need to be inserted inside the pit till the hard strata of the pit. The soil which comes within the rod needs to be observed carefully.) After confirming that decomposting is completed, pit should be kept open for few hours, so that any insects or reptiles or small animals living inside should come out of pit. If possible, this pit should be kept open for one complete day. (While keeping this pit open, care should be taken that no water, children or any animal should go inside and any accident should not take place.) Most of the decomposed

feacal matter is of cake like shape which is in the centre of the pit and is away from the outer walls of the pit.

8. If faecal matter is not fully decomposed, then ash should be spread/sprinkled on the top of the partly decomposed night soil so that extra dampness/ water content can be absorbed by the ash. This will make it dry soon. Such pit should be kept covered and needs to be inspected regularly and when the night soil manure is ready, then only it should be emptied.

9 To empty the pit, regular farming instruments/tools like pick, spade, hoe, sickle, iron/plastic pan/basket are required. Night soil manure which can be easily removed from outside the pit, should be taken out first. Then remaining material should be taken out by physically going inside the pit. For this two persons may be required. One person will go inside the pit and take out the manure while the other person will collect the same and spread it on a plastic sheet kept on the ground. Generally, from one pit, we should be able to get 90 to 130 kg night soil manure. To empty one pit completely, 3 to 4 hours' time will be required.

10 This manure is generally bound tightly in the form of lumps. These lumps should be loosened and materials like, sticks, roots of trees, clothes, glass, etc. if found, separated and it should be sieved with the help of sieving net. This sieved fertilizer/manure should be kept in the gunny bags for use in gardening or farming. While packing the manure, if there is a little moisture, do not worry and let it be as it helps in protecting some of bacteria. This night soil manure is commonly called as "Sonkhad/Golden compost". It has been seen that use of manure increases production and quality of crop on which it is used, and also reduces input fertilizer costs. If not used in own garden/farm, the manure can be sold to other local farmers/gardeners.

11. Pit from which night soil manure has been removed, needs to be cleaned, and the honeycombing in the walls checked. If it is found damaged, then it should be repaired with the help of a mason. Pit should be kept exposed to sunlight for 2 to 3 days, and then kept ready so that it can be reused whenever required.

12. Finally, it may be noted that removing night soil manure from twin leach pit latrine is very simple procedure. It can create good employment opportunities in rural areas where twin leach pit latrines are constructed largely in numbers.

(Reference: Leaflet on 'Steps for Emptying of Twin Leach Pit Toilet' by UNICEF)

6.1.6 Points to remember

Removal of manure from the pits is not only easy but joyful. This is organic manure and it contains almost all the basic plant nutrients including Nitrogen (1.5%), Phosphorus (1.07%), and Potassium (0.5%). It can be used in any crop and even in the domestic garden. Since it is organic manure it gives very good results and has no ill effects at all. Recycling of human excreta into manure is our national duty.

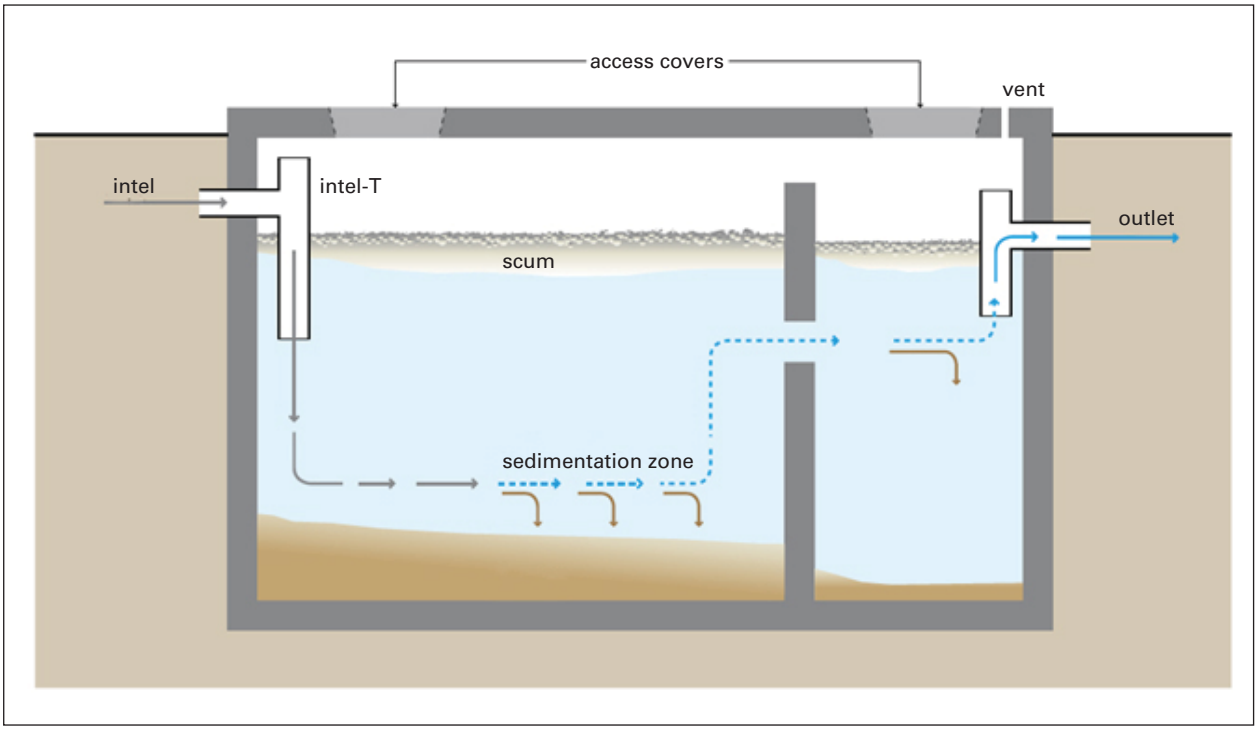
6.2 Septic tank toilet

6.2.1 Technical details

This technology too is common in rural areas of Maharashtra. A septic tank is designed to allow settlement and decomposition of waste water. Heavy solids in the water settle at the bottom of the septic tank and lighter solids float on the liquid surface in the form of scum. Thus, water with minimum solid content floats in the middle portion of the septic tank. This partially treated water is supposed to move forward and to be removed from the septic tank. The water is taken forward without disturbing the process of sludge digestion. Organic matter in the sludge and scum layers is broken down by bacteria which convert it to liquid and gas. The process is called sludge digestion. Methane and other gases generated during decomposition process are discharged by a vent pipe on the tank.

6.2.2 Construction of leach pits/ soak pits

In septic tank toilet, construction up to plinth level and superstructure is similar to pour flush toilet. Appropriate construction of septic tank is the most important part and as mentioned above;the septic tank needs to be designed with a 45 days retention time. Septic tank is divided into either three or two chambers. When three chambers are provided all the chambers are of equal size. If two chambers are provided the size of the first chamber is kept 2/3 and second chamber is 1/3 of the length.



6.2.3 What precautions need to be taken after the construction of toilet?

- Never allow the effluent of septic tanks to flow in the open or in an open drain. This can cause water pollution and spread diseases. This is also against the law. Instead, make a provision of a soak pit or leach pit of appropriate volume to accommodate the effluent.
- Always provide a vent pipe to evacuate the obnoxious gases from the septic tank. The vent pipe should have 3" diameter, should raise above the nearest building structure, should have a cowl on the top for proper ventilation and a mosquito screen wrapped around it to avoid access to mosquitoes
- Empty Septic tank- Emptying of a septic tank is very important for the safe use of it. The septic tank must be emptied after equal intervals.
- Keep an eye on the behaviour of septic tank – (changes in water level, drainage of waste, etc.)
- Having your septic tank of good material is of sheer importance. Strong and reliable septic tank can avoid any problems in the future.
- The septic tank should not be near a tree or plant or a tree near a septic tank. The roots of the trees are very strong, and they can crack the boundaries of the tank.
- Use of adequate water for flushing

6.2.4 Limitations:

If the septic tank is not of appropriate size or if the number of users is more, untreated water starts leaking from the outlet, causing health and environmental hazards.

- Lot of water needs to be used in this technology for preventing chocking of inlets and outlets.
- Cost of construction is high.
- The septic tanks need to be desludged periodically, and no byproduct is produced which can generate income.
- The methane generated during decomposition process is harmful for the environment and also cannot be harnessed as source of fuel.

6.3 Biogas

6.3.1 Technical details

Biogas is an anaerobic technology where decomposition of waste material takes place with the help of microorganism that can grow in the absence of oxygen. The biogas contains 50-70% Methane, 30-40% Carbon dioxide and other gases. Methane is a flammable gas and can be used as alternative sources of fuel for domestic and commercial use. Calorific value of the biogas is 20 MJ / M3 and its 60% efficiency can be used through burner.

Biogas system has four important parts- Inlet chamber, Digester, Outlet chamber and Gas collection chamber.

Inlet chamber – In this chamber solid waste and other biodegradable material such as cow dung are mixed together with water.

Digester – Digester is a closed chamber. Content in the inlet chamber enters the digester and actual process of decomposition takes place in the digester.

Outlet chamber – After completion of the decomposition process the solids in the slurry form gets collected in the outlet chamber. This slurry is spread on the drying

beds and further it can be applied in the agriculture fields.

Gas collection chamber – This chamber is located in the upper part of digester. Gas generated during the decomposition process is collected in this chamber. Gas from this chamber is carried through a pipeline and is used as a fuel source.

Biogas system is available in two types- Fixed dome biogas and floating dome biogas. Fixed dome biogas further has three types namely Janata Biogas, Deenbandhu Biogas and Malprabha Biogas. Floating dome biogas has further three types namely K.V.I.C. Biogas, Water Jacket Biogas and Pragati Biogas.

6.3.2 What precautions need to be taken after the construction of toilet?

- Regularly check the whole system for leaks.
- Provide ventilation around all gas lines.
- Always maintain a positive pressure in the system.
- Metal digesters and gas storage tanks must have wires to lead lightning to the ground.
- Gas lines must drain water into condensation traps.
- No smoking or open flames should be allowed near biogas digesters and gas storage tanks, especially when checking for gas leaks.

6.3.3 Limitations

Waste of at least 2-3 cattle is required for functioning of biogas. Biogas cannot be generated solely on human waste. Animal waste slurry is essential.

Hydrogen Sulphide gas is produced along with biogas. Human contact with the digester is therefore harmful.

CHAPTER 7

Various technical options for collection and transportation of faecal sludge

The collection of faecal sludge from septic tank/ soak pit and its safe transportation is the most important aspect in faecal sludge management practice as all subsequent processes primarily depending on it. At present, there are various types of technologies available in the market for collection and transportation of faecal sludge. Some of the globally available technologies are provided in the table below:

Technologies for collection of sludge	Technologies for transportation of sludge
Gobbler	Vaccutug
MAPET	Grapler
Pit Screw Auger	Shilfter
Diphragm	Dung beetle
Omni ingester	Vaccum tug UN-habitat
Gulper	Tricycle mounted transportation system

Most of the above listed technologies are used globally for collecting and emptying faecal sludge. The required capital investment, O&M and other additional expenditures for procuring these services makes them less preferable and affordable in rural context. Considering this fact, following technology options which are less capital intensive, having less O&M expenditure and less expensive service charges are summarized in subsequent sections.

7.1 Vacutug

7.1.1 Technology specific information

Vacuum tugs/ Vacutugs are used for de-sludging and transportation which principally operate on vacuum suction. These mechanical systems are used for emptying pits and septic tanks. The equipment was first built by Mirpur Agricultural Workshop and Training School (MAWTS) in Dhaka during the year 2002. This simple portable machine is highly navigable through narrow streets to access hard to reach extraction points which may be unreachable to large machines.

7.1.2 Technology and working principles

It is important to automate the task of emptying septic tanks and pit latrines to avoid manual removal of sludge, and hence these machines have been designed to operate on the principle of vacuum suction. The Vacutug comprises a vacuum tank having a size of 0.5 cubic meter, connected to a sliding vane vacuum pump capable of producing a-0.8 bar vacuum. The machine is fitted with a clutch in the form of an adjustable drive, a throttle and two brakes. The front wheels are driven by a petrol engine connected either to a vacuum pump or a friction roller, through an adjustable belt drive. The vacuum tank is fitted with 3-inch diameter valves at the top and bottom of it and the sludge is extracted from the pit through a PVC vacuum hose. If the sludge is dense, water is added to the pit/ septic tank so that it can be pumped out easily. After extraction is complete, the sludge is transported to a disposal site where it can be discharged by gravity feed or pump pressure via the flexible hose.

<table>
<tr><td colspan="2">  </td><td colspan="2">Four wheeler
Engine powers both the pump and equipment
Vertically mounted sludge collection tank
Easy to move
Models – MK I/II/III/IV/V</td></tr>
<tr><td>Capacity of Tank</td><td>Pump</td><td>Engine</td><td>Max Speed</td></tr>
<tr><td>500-2000 L</td><td>MEC2000/P</td><td>10hp/ Diesel</td><td>1-5 km/h</td></tr>
<tr><td>Weight</td><td></td><td></td><td></td></tr>
<tr><td>950 Kg</td><td></td><td></td><td></td></tr>
</table>

7.1.3 Limitations

- Difficult to extract sludge in solid form, especially when pit is deeper than 2m. Pipe may get damaged while extracting sludge in dry condition.
- Service cost of deploying Vacutug is bit costlier than informal process of collecting/emptying faecal sludge
- Vacutug is effective when operated for distance of 1-5 km between the point of extraction and location of disposal
- Max speed of 5 km/h

7.1.4 Cost*

Model	Capacity	Rs. (in Lakh)
Mark I and II	500	6.50
Mark III	1900	13.00
Mark IV	700	9.76
Mark IV	1000	9.76

Source: Faecal sludge management, system approach for operation and maintenance management, edited by Linda Strande, Mariska Rontelta and Damir Brdjanovic.

Note: Actual market rates may vary from the above mentioned costs

*Rates may be vary for each technology

7.1.5 Maintenance and repairs

- For regular cleaning of machine, collection and emptying of sludge, maintenance and repair of the machinery, two trained persons are required.
- Less expenditure required for O&M; Only regular servicing of the equipment is importantly required for extending the service life of machine
- Required safety equipment – Helmet, Hat, safety Glasses, Filter Mask, Apron, Gloves, Gumboots
- Frequently required spares – *Shovel* (to open manhole cover), *Kerosene* (to decrease odour in septic tanks and pit latrines), *Bleaching Powder* (to disinfect gumboots, gloves, hoses and the area around manhole), *Bucket* (to carry fresh water, collect sludge spill), *Detergent and Soap* (to clean gumboots, gloves and hands)

7.2 Gulper

7.2.1 Brief about the technology

Manual De-sludging Hand Pump or Gulper is the only technology which is portable and reduces sludge contact as it consists

of PVC riser pipe containing two stainless non-return butterfly valves. The Gulper is a recent invention which is inexpensive and easy to operate. Adverse health impact is significantly reduced as there are very less chances of sludge contact. The Gulper can be built using locally available material and manufacture techniques, even those which are common in low-income countries. This technology is very much suitable for densely populated and low-income areas.

7.2.2 Description and working Principle

The Gulper houses a piston pump on top of a pipe with an outlet pipe on the side. The upward movement of piston draws sludge through a valve into the cylinder and then discharges during the downward movement through a valve into the outlet. During the de-sludging process, the sludge is accumulated in a bucket placed under the outlet pipe; whereas the bottom of the pipe is kept into the pit or septic tank. The pump is usually operated by 2-3 workers by way of pushing and pulling of lever on top of the Gulper.

7.2.3 Cost

Rs. 8000- 10000/-

7.2.4 Maintenance and repair

- To increase the service life of equipment, the pump is required to be cleaned after every de-sludging process
- Blockages resulted by higher amount of non-biodegradable material have to be removed whenever required
- Required safety equipment – Gloves, Gumboots, Filter Mask, Hat, etc.

7.2.5 Limitations

- Time required for de-sludging is more
- De-sludging is not effective/ doable when pit is very deep
- Solid wastes choke the system and may lead to delays in operations
- Dried or thick sludge cannot be removed

7.3 Vacuum pump (E-VAC)

7.3.1 Brief about the technology

Vacuum pumps are proven devices in de-sludging faecal sludge from pit latrines/ septic tanks. Also known as E-VAC, the vacuum pumps have the benefit of both the vacuum suction and the swiftness of a small system for effective operations in densely populated areas.

7.3.2 Description and working principles

E-VAC works on similar principles of other Manual Pit Emptying Technology (MAPET); however the fundamental difference is that

E-VACs are externally powered. The pump is operated by using a small motor which is powered by onsite electricity or using a portable generator. A belt drive combines the pump and motor which is then mounted on a steel trolley. This kind of arrangement allows the housing of equipment and its maintenance. There are two kinds of models available in the market. The first one has a small tank attached to it whereas the second one has an arrangement of connecting pump to any container which is used for collection and transporting of sludge. In both the models, a float valve is provided so as to prevent sludge from entering into the pump.

7.3.3 Limitations

- The rate of emptying is low which restrict the pump's application only to the small containment systems (pits/ tanks)
- Can only be used for low viscous sludge
- There is a possibility of sludge spillage while transferring the containers

7.3.4 Cost

Sr.	Details	Cost
1	Suction Machine Mounted on Trolley. (Vacuum Emptier) capacity 3000 ltr.	4,90,000/-
2	Suction Machine Mounted on Chassis. (Vacuum Emptier) capacity 3000 ltr.	4,11,700/-
3	Suction Machine Mounted on Trolley. (Vacuum Emptier) capacity 5000 ltr.	6,12,000/-
4	Suction Machine Mounted on Chassis. (Vacuum Emptier) capacity 5000 ltr.	5,60,000/-

Source: As per Rate Card of Ozone Envirotech, Moshi, Pune

7.3.5 Maintenance and repairs

- Regular oiling and greasing of pump is required
- Equipment is required to be cleaned frequently in case of spillage and overflows
- Valves should be cleaned for blockages and external particles

7.4 Conventional vacuum tankers

7.4.1 Brief about the technology

Vacuum tankers comprise of a truck or any other vehicle combined with tank and a vacuum pump. They use de-sludging technology having a high tank volume, faster rate of emptying and high mobility.

7.4.2 Description and working principles

Vacuum tankers can empty pits or septic tanks at much higher rate and carry large quantity of sludge much faster. They are generally fitted with storage tanks having capacity of 2000-15000 litres. These tanks are fitted with vane pumps. The pump generates a suction pressure inside the tank which enables de-sludging of septic tanks through a hose connected at the outlet of the tank. A suitable apparatus is provided to prevent sludge getting into the vacuum pump and damaging it.

In this type of technology, different types of vane pumps can be installed based on the consideration of cost, capacity and liquid range within which the pump is most suitable to operate. The pump is efficient enough to suction out the settled thick sludge at the bottom of septic tank very conveniently. This type of arrangement consists of three main components: constant air drag, air bleed and plug drag.

In general, following things should be noted while using this technology and associated features:

- Total capacity of storage tank and the level beyond which the sludge suction should be tripped off.
- Point of extraction and its connecting road (length and width) in order to assess the possible difficulty while accessing the desired point.
- Scope of total quantity for de-sludging
- Financial provision
- Availability of skilled labour, etc.

7.4.3 Cost

The capacity of the tank varied from 2000 litres to 15000 litres. The vehicle for Vacuum Tankers needs to be assembled locally. Similarly, the pump capacity also varies depending on local situations and choice of the service provider. Therefore, the cost may vary depending upon the type of vehicle, pump and storage capacity.

7.4.4 Limitations

- Cannot access all types of roads, especially the smaller ones
- Difficulties associated with choking of trash at the inlet
- Higher capital and operating expenditure
- Requires repairs which can cause long delays

7.4.5 Maintenance and repairs

- Regularly check of level of oil in oil cooling tank, hydraulic tank, engine etc.
- Checking of coolant
- Tire pressure, headlights, indicators to be checked weekly

CHAPTER 8

Treatment technologies for faecal sludge management

8.1 Introduction

Due to growing concerns of adverse impact on environment and human health, scientific treatment of faecal sludge is very crucial. It is also important to collect and treat the faecal sludge from septic tank toilets to be further used as soil conditioner. Presently, there are various globally adopted technologies and processes for treatment of faecal sludge. In the State, sewage treatment plants are set up for the treatment and disposal of faecal sludge at city level. However, this is not the sole alternative which is employed at every location. In rural context, the treatment technologies should not only be evaluated on the basis of cost, but also ease of operations and sustainable O&M. On the other hand, centralised treatment options- either at block or cluster level should be explored thoroughly rather than just selecting an independent treatment facility for each village.

Based on the above mentioned aspects, several treatment technologies applicable in rural context have been reviewed and summarised as below:

- Unplanted drying bed
- Planted drying bed
- Tiger Biofilter
- DEWATS

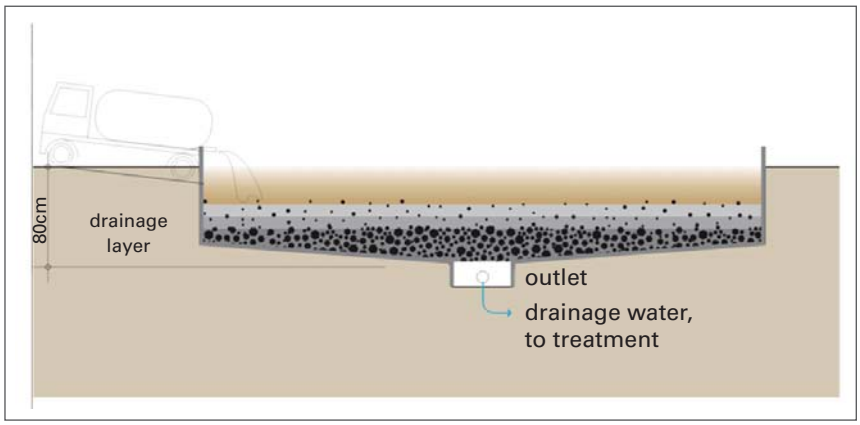
8.2 Unplanted drying bed

8.2.1 Brief about the technology

This is a simple technology which includes permeable bed filled with a number of drainage layers. These layers attributes to percolation and evaporation of percolated leachate when loaded with the sludge. About 50-80% of the sludge volume is evaporated or drained off as liquid. The remaining substance is then exposed to drying process. The sludge is treated by composting before it can be disposed of or used as a nutrient-rich soil conditioner in agriculture. However, the compost still contains pathogens and requires further treatment.

8.2.2 Description and working principles

The technique of reducing the volume of sludge and prepare its reuse as fertiliser is one of the simplest and oldest to dewater sludge. Perforated pipes are located at the bottom of the drying bed to drain away the leachate. Layers of gravel and sand placed on top of these pipes support the sludge and allow the liquid to permeate. Sludge is laid on top of gravel beds and is naturally dried for 10-15 days, after which the moisture content is reduced by about 60%. Sludge is applied in batches about once in a week in layers no more than 200 to 300 mm from both the sides. The solid fraction of sludge remains on the filter surface and is dried by natural evaporation while the liquid fraction percolates. Once the sludge is



dried, it is separated from the sand layer and transported for further treatment whereas the leachate collected in drainage pipes is treated further before final disposal.

8.2.3 Design factors

- Sludge is applied in a batch mode about once per week in layers of no more than 20 to 30cm.Around 100 to 200kg TS/m2 of sludge can be applied on a drying bed, on an annual basis. The drying process usually takes 10 to 20 days
- Land requirement is 0.05 square metre per capita for a 10-day cycle
- Before fresh sludge is applied, dried sludge needs to be de-sludged, and then brought to a composting site
- To improve drying and percolation, sludge application can alternate between two or more beds. About 50–80% of the initial volume is removed by percolation, resulting in a total solid (TS) content of 20–70%, depending on the local weather conditions and climate
- A splash plate has to be provided at the inlet to prevent erosion of the sand layer and to allow for even distribution of the sludge
- While designing unplanted drying beds, ensuring accessibility to people and trucks into the site for regular maintenance at all times is absolutely essential

8.2.4 Cost

Approximately Rs 1,675 per person[3]

8.2.5 Limitations

- Treated compost contains pathogens which still requires further treatment
- Dried sludge is required to be removed completely before applying the fresh sludge
- This treatment process requires larger land area in addition to mechanical power for regular de-sludging
- Additional sand is required to be added if the thickness of sand layer is reduced

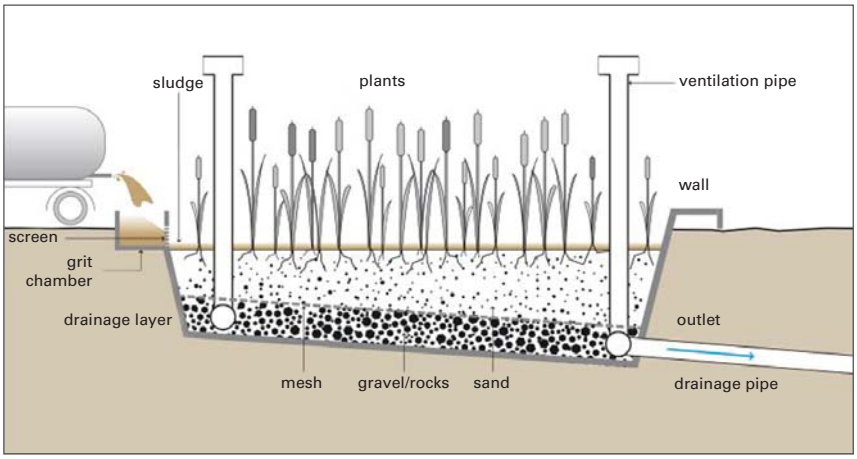
8.2.6 O&M requirements

- Trained personnel is required
- Dried sludge is required to be removed generally after 10–15 days
- Top layer should be replaced when it gets reduced

8.3 Planted drying bed

8..3.1 Brief about the technology

In this technology, a shallow pond consisting of several drainage layers are provided to separate the liquid fraction of faecal sludge by way of percolation and evaporation. The planted bed is advantageous as the filters



[3] Cost is calculated based on Wai and Sinnar plants

do not need to be de-sludged after every drying cycle. This enables the application of fresh sludge directly on top of the previously applied layer. Also, the plants and their roots help in maintaining the porosity of the filter. Planted drying beds require de-sludging only once after 5-10 years. The removed sludge, being a nutrient-rich soil conditioner, can be directly reused in agriculture.

8.3.2 Description and working principles

The bed frame is typically made from concrete or a plastic liner having bottom surfaces slightly sloped in order to facilitate percolation and drainage. After that, general layering of the bed is constructed by laying 250 mm of coarse gravel, 250 mm of fine gravel, and 150 mm of sand layer. Depending upon the local climatic conditions, suitable non-invasive plant species like Reeds, Cattails, Antelope grass and Papyrus are planted on top of the bed.

After preparing the bed as mentioned above, the sludge is applied in layers having thickness of about 100 mm after every 3 to 7 days. Such layer is created by placing the sludge into a grit chamber constructed on one side of the bed. Solid fraction of sludge is screened at the grit chamber whereas the liquid fraction flows down towards the planted bed through outlet. The plants enhance evaporation by transpiration. This process is continued for about 5 to 10 years and yields a nutrient-rich soil conditioner.

8.3.3 Design factors

- The bed frame is usually made from concrete or a plastic liner with the bottom surfaces slightly sloped in order to facilitate percolation and drainage
- A general design for layering the bed is:
  - 250 mm of coarse gravel (grain diameter of 20 mm);
  - 250 mm of fine gravel (grain diameter of 5 mm); and
  - 100 to 150 mm of sand (EAWAG/ SANDEC 2008).
- Free space (1 m) should be left above the top of the sand layer to account for about years of accumulation.
- Ventilation pipes connected to the drainage system contribute to aerobic conditions in the filter
- Reeds, cattails, antelope grass and papyrus are suitable plants, depending on the climate. Local, non-invasive species can be used if they grow in humid environments
- Sludge should be applied in layers between 75 to 100 mm thick and reapplied every 3 to 7 days, depending on the sludge characteristics, the environment and operating constraints
- Planted beds do not need de-sludging before each new application as the root system of the plants maintains the permeability
- Sludge application rates of 100 to 250 kg/m2/year have been reported in warm tropical climates. In colder climates, such as northern Europe, rates up to 80 kg/m2/ year are typical
- It is best to stop applying sludge one or two years before removing it

8.3.4 Cost

Approximately Rs 1,700 per person[4]

[4] Cost is calculated based on discussions with Wai and Sinnar plant technicians

8.3.5 Limitations

- The treatment process involves risk of health hazards and thus necessitates the use of protective wear, gumboots and gloves by workers
- In dry climatic areas, low moisture content creates harsh conditions for plant growth
- Due to odour issues, the bed should be located at a distance from the human settlements
- Percolates from sludge drying beds contain pathogens and need to be further treated

8.3.6 O&M requirements

- Skilled labours are not required as planted beds are easy to operate
- Maintenance activities should ensure that trees do not grow in the bed as roots can damage the lining of the drying bed
- During the first growing season it is important to remove weeds that can hinder the growth of planted vegetation
- Distribution pipes should be cleaned at least once a year

8.4 Tiger biofilter

8.4.1 Brief about the technology

Tiger Biofilter technology is based on the process of vermi filtration. In this technology, various types of filter media and bio media are used together with worms and bacterial culture, which contributes to easy and natural purification of wastewater. The percentage of water recovery is about 90-95%. During the process, no sludge is generated and hence there is no need to separately manage the sludge unlike other faecal sludge treatment options. Apart from this, a nutrient-rich soil conditioner is generated which can be further used for agriculture and gardening.

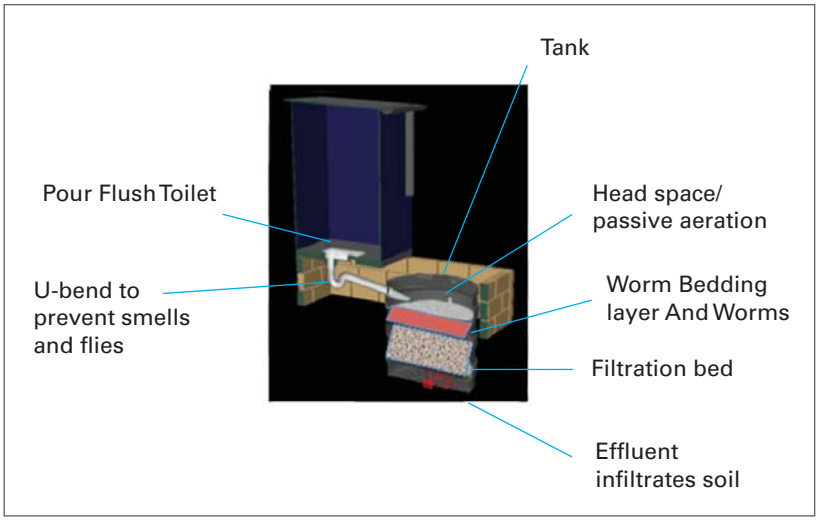
8.4.2 Description and working principles

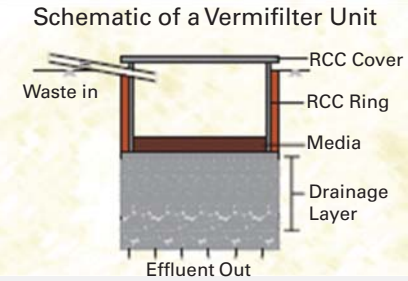
Tiger Bio filter is divided into two main parts: one is filter media and second is bio media. In filter media, good quality of aggregates, sand etc. are used as simultaneous layers. These layers are used for supporting the bio media and filtering water. Bio media layer consists of earthworms, bacterial culture and its ecosystem as well as bio culture.

The impurities in wastewater are trapped inside these layers and filtered water percolates and gets collected in the storage tank located at the outlet. Waste which is trapped inside the layers is converted into compost with the help of worms and bacterial culture. This process is followed on daily basis which in turn eliminates the odour generation and mosquito/flies breeding.

8.4.3 Technology specifications:

Tiger toilet system requires a single Pit incorporating vermifilter, specifications of which have been presented below.



Component	Specifications	Basic functioning	Schematic of a Vermifilter Unit
Single Pit	Inner diameter- 1 m Depth- 1.2 m	Rapid decomposition of excreta in the pit due to a specially designed Vermifilter. No solid accumulation.	

8.4.4 Benefits

Following are the benefits of the technology-

- No need of handling sludge as faecal sludge is rapidly converted Into vermicompost
- Safer and easier emptying as vermicompost is stable, soil-like material and can be readily removed
- No energy requirements as it is a passive Process
- Cheap to construct and run, the Vermifilter is not expensive like the other technologies in the market and does not require special tanks to be constricted. It can be easily installed in existing pit design. Dosage of media is required only once to get the system running.
- Compact with a smaller footprint than a septic tank or a twin pit latrine
- Little or no maintenance needed
- No smells as the system is aerobic
- No risk of mosquito breeding

8.4.5 Cost

Approximately Rs 850-900 per person

8.4.6 Limitations

- Wastewater containing chemical impurities and solids requires pre-processing
- The compost generated by the process contains pathogens and thus need to be handled properly

8.4.7 O&M requirements

Generally, the compost should be removed once in 6-8 months

Proper action would be required if the content of grit is more

CHAPTER 9

Planning, implementation and monitoring of FSM

The urban systems for FSM are not suitable for rural areas due to various reasons like inadequate finance, insufficient availability of skilled human resources, scale of operations, etc. Therefore, in rural areas, it will be more appropriate to create systems for FSM at block or cluster level. Following section presents the methodology of planning for FSM.

9.1 Methodology of planning for FSM

Various steps need to be followed for effective planning of FSM in rural areas. The key steps in planning are presented in the adjacent schematic and described below in detail.

9.1.1 Baseline survey and validation based on FSM value chain

The first step in the planning process is to carry out a baseline survey of the area where FSM systems need to be set up. Area specific policy for faecal sludge management may be decided based on local conditions and specific issues.

9.1.2 Finalization of project area

As discussed above, it will be appropriate to set up FSM systems at block or cluster level. A cluster of 10-15 GPs can be finalized for FSM based on digital maps procured from government or online web based services. Connectivity between the GPs, location of the GPs and no. of septic tanks can be the criteria for selection.

9.1.3 Organization of FGD at cluster level

A meeting of Sarpanch/ gramsevaks from the selected GPs may be organized at cluster/ block level. During this meeting, firstly the status of sanitation and faecal sludge management in the block based on type of toilets may be discussed. Then, information about the selected villages may be provided and clarity may be brought about the activities to be done at various levels of the FSM value chain. Support requirements from the GPs may be discussed in the end.

9.1.4 Household survey

After the FGD, household survey may be conducted in the selected GPs to collect data on type of toilets, technical appropriateness of the toilets, etc. A draft tool for the household survey is presented as annex.

9.1.5 Collection of secondary data

Next step is to collect information about the existing FSM service providers in the area. Information of FSM service providers will be collected based on the steps in value chain, type of technology used, whether the providers are private or government empanelled, cost of services, etc.

9.1.6 Analysis of collected information

A. Analysis of the household survey data

Based on the data collected at various stages of planning, the number of households from the selected GPs which require desludging services will be finalized. Additionally, a list of toilets with technically inappropriate construction or tanks without lids will be listed and submitted to the GP. The GP will be asked to provide instructions to the households regarding fixing lids on the tanks.

B. Analysis of the pit empting and transportation services

Once the number of toilets requiring desludging services is finalized, the capacity of the selected technology would be decided. An overview of how many service providers exist and are ready to provide services would be undertaken. Additionally, a timetable, frequency and route for desludging will be decided.

C. Analysis of the treatment services

Treatment of the faecal sludge is very important. First of all the volume of faecal sludge to be treated per day would require to be calculated. Based on this data, capacity of the available treatment plant will be reviewed. Communication with the concerned government department will be done to avail the facilities.

In case of non-availability of the treatment plant, setting up of a new treatment plant will be proposed. Location of the plant will be finalized in such a way that the distance between the desludging and treatment locations will be minimal. This will save the cost of transportation. Other important criteria for location finalization will be availability of electricity connection, distance from the settlement (so as to save the people from foul smell), density of population, type of soil, characteristics of the treated water, and cost of O&M.

9.1.7 Preparation of budget

After collecting the required data of service providers at various stages of FSM service value chain, communication will be established with the service providers for empanelment/ procurement. If such facilities are not available at cluster/ block level, contractors from outside may be procured. Innovative, low cost technologies may be selected which will require less skilled human resources. Based on the above, a budget for setting up FSM system will be prepared and get approved from the concerned department.

9.1.8 Resource mobilization

Resources will need to be mobilized for the following three types of activities regarding FSM.

A. Pit emptying and transportation

Two options can be considered for undertaking these activities- one, to set up pit emptying and transportation systems in a big GP/ census town in the cluster and provide services through this GP; and second, to motivate SHGs for providing these services. In case of the first option, funds from 14th finance commission grants from

all selected GPs in cluster can be pooled as a resource pool for FSM services. In case of the second option, SHGs can be provided financial support through Maharashtra State Rural Livelihood Mission (MSRLM), MAVIM, CSR, bank loans, etc. However, for its operationalization, there needs to be effective convergence between various government departments at block and district level. The SHGs will also require technical assistance in the beginning.

B. Setting up of treatment plant

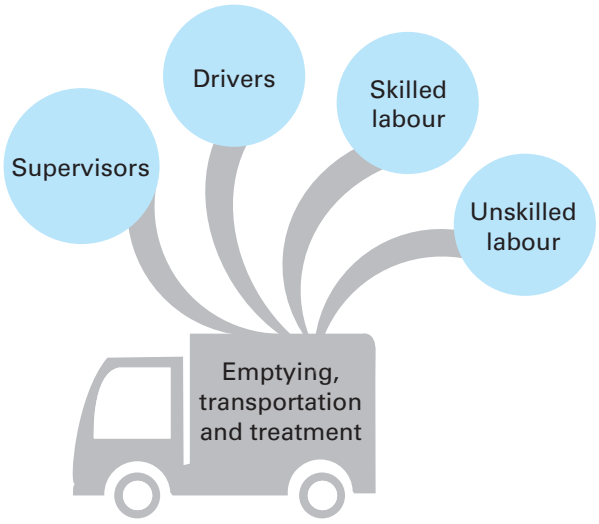
As mentioned above, funds from 14th finance commission grants from all selected GPs in the cluster can be pooled to form resource pool for setting up of treatment plant. Apart from this, 14th FC funds can be used for preparation of DPRs. If the treatment plant is to be set up by the GPs, the cost will be distributed between the GPs. It is important for the GPs to have trust in each other to arrive at unanimous decision.

C. Operation and maintenance

Regular operation and maintenance of the FSM systems need sustained availability of required funds. Few cost heads like salaries, electricity bills, cleaning material and chemical, fuel, periodic repairs, etc. need regular funds. The participant GPs can levy sanitation tax on the villagers. Simultaneously desludging and transportation of faecal sludge can be charged for revenue generation.

9.1.9 Human resource management

The human resources required for various steps of FSM are presented in the schematic. In case skilled human resources are not available, unskilled HR may be trained through various training programs.



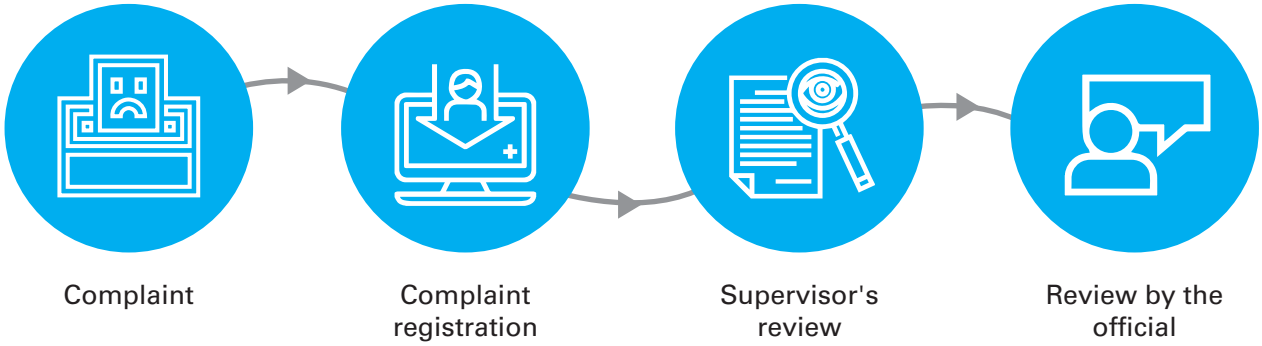
9.1.10 Monitoring

Monitoring of any process is important for effective implementation of the steps and ensuring the expected outcomes. Following table presents the monitoring framework at various steps of FSM.

No	Step	Monitoring activities
1	Pit emptying	Adhering to the security norms Following Manual Scavenging Act 2013. Collection of pit emptying tax
2	Transportation	Regular repairs of vehicles. Application of GPS units in all vehicles and monitor their routes Discharging the faecal sludge safely in the treatment plant

3	Treatment	Discharging the faecal sludge in the treatment plant as per its capacity Ensuring that the treated byproducts are of the specified characteristics Regular pumping out of dried sludge
4	Use	Following Water pollution and environment security act Testing the quality of manure Charging appropriate price for the manure

Satisfaction of consumer is the motto of any service provider. However, considering various types of consumers of FSM services, it is not possible to get service related feedback from every consumer. A complaint redressal system is therefore necessary to resolve any complaint/ grievance of the consumers. Various methods like complaint register kept at the GP or using software applications can be considered for setting up efficient complaint redressal systems. A supervisor may be appointed for monitoring the complaint redressal mechanism.



ANNEX 1

Household survey format

No	Question		Option
1	Format no.		
2	Details of the habitation	1	Gaothan
		2	Habitation
3	Name of the habitation		Name
4	Ward no.	1	No.
5	Type of property	1	Household
		2	Institutional
		3	Business
		4	Other (details)
6	Type of house (if option 1 ticked in question no. 5)	1	Bungalow
		2	Row house
		3	Hut
		4	Temporary structure
		5	Permanent structure
		6	Other _____
7	Type of institute (if option 2 ticked in question no. 5)	1	Hospital
		2	PHC
		3	School/ college
		4	Religious institute
		5	Other _____

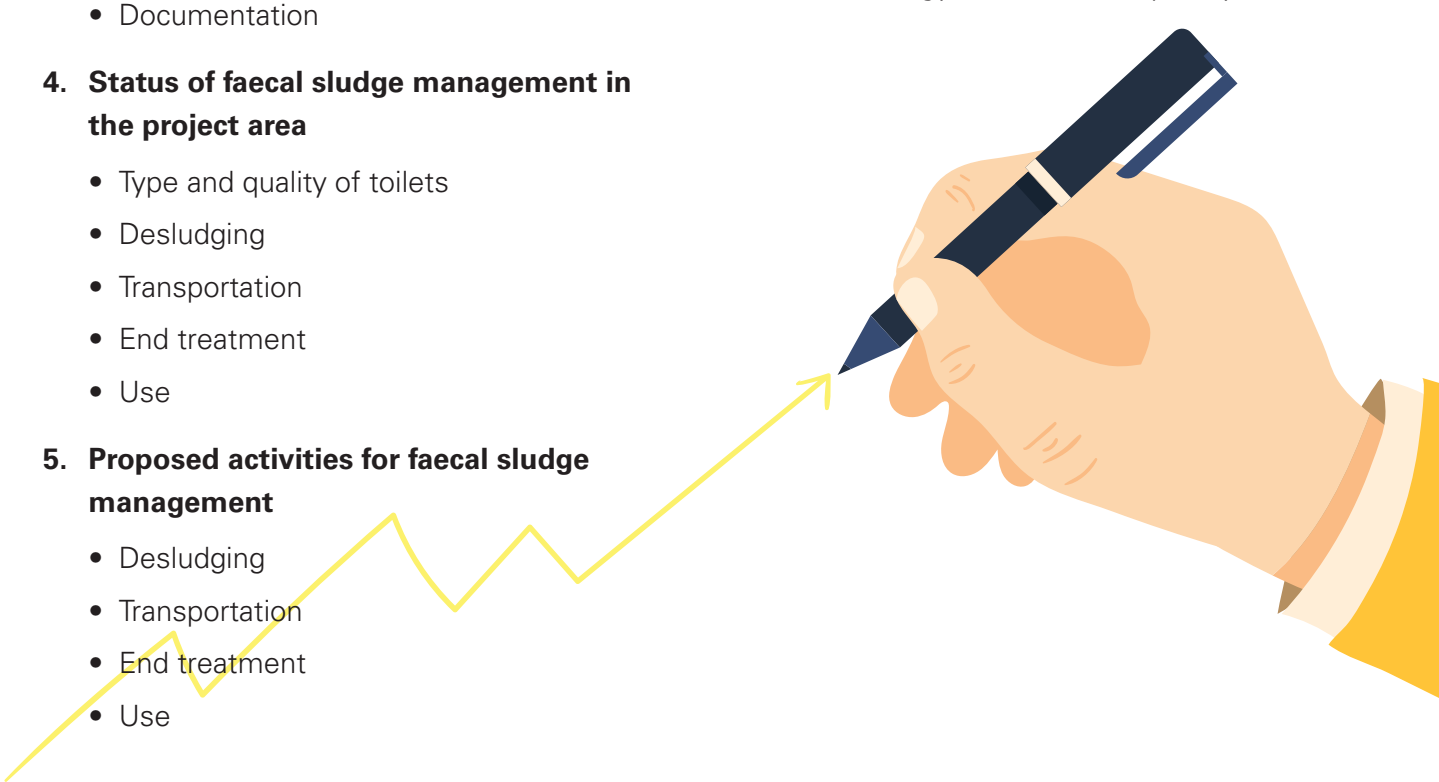
No	Question		Option
8	Type of business (if option 3 ticked in question no. 5)	1	Industry
		2	Shop
		3	Hotel/ lodging
		4	Other _____
9	Name of head of the family	1	_____
10	Contact no		
11	Is there and individual toilet in your house?	1	Yes
		2	No
12	If yes, no. of toilets		Number_____
13	No. Of users In case of business, mention approximate number of users)		Children (Below 6 years) _____ Men _____ Women _____
14	Type of toilet	1	Septic tank
		3	Single pit
		6	Other (Mention)
15	In case of septic tanks, please mention no. of tanks	1	1
		2	2
		3	3
		4	4 Don't know
16	Use of toilet (Individual/shared/public)	1	Individual
		2	Public
17	What is the shape of septic tank?	1	Square
		2	Round
		3	Don't know
		4	Rectangle
18	Dimensions of the septic tank	1	Length
		2	Breadth
		3	Height
19	Where is the septage discharged	1	Soak pit
		2	Open gutter
		3	Closed gutter
		4	Open space
		5	Other----------
		6	Don't know

No	Question		Option
20	When was the tank emptied	1	6 months ago
		2	6 – 12 months ago
		3	12 – 24 months ago
		4	24 – 36 months ago
		5	More than 36 months ago
		6	Never emptied
		7	Don't know
21	Reason behind empting the septic tank	1	Toilet blocked
		2	Water leakage from chamber/ lid
		3	Foul smell
		4	Other _____
		5	Don't know
22	Problems faced during emptying	1	High distance for transportation
		2	Narrow road
		3	Did you need to break the flooring for emptying septic tank?
		4	Did you need to break the cement lid for emptying septic tank?
		5	Did you face problems in identifying the location of septic tank?
		6	Was there foul smell during for emptying septic tank?
		7	Any other issue in emptying the septic tank?
		8	No problems faced
		9	Others
		10	Don't know
23	Was the suction truck easily available for emptying the septic tank?	1	Yes
		2	No

ANNEX 2

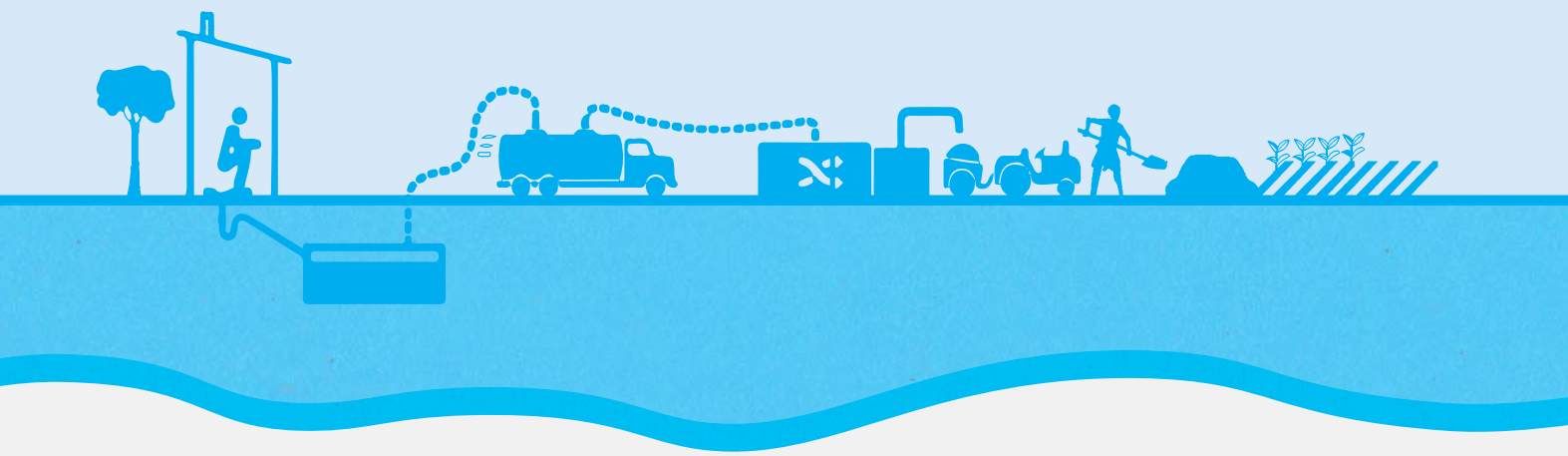
Report template

1. **Background**
2. **About the project area**
   - Name of the finalized cluster, details, centre of the cluster, distance between GPs, etc.
   - Profile of the participant GPs- population, number of households, details of toilet coverage (households with and without toilets, types of toilets, etc.)
3. **Process for report development**
   - Secondary data collection
   - Focus group discussion
   - Study of the FSM value chain
   - Household survey
   - Data validation
   - Documentation
4. **Status of faecal sludge management in the project area**
   - Type and quality of toilets
   - Desludging
   - Transportation
   - End treatment
   - Use
5. **Proposed activities for faecal sludge management**
   - Desludging
   - Transportation
   - End treatment
   - Use
6. **Implementation of the proposed activities**
   - Process for purchasing desludging and transportation equipments
   - Administration of the treatment plant
   - Capacity building
   - IEC
   - Others
7. **Operation and maintenance**
   - Systems
   - Collection of service tax
   - Planning
   - Work methodology
8. **Monitoring**
   - Methodology, levels and frequency



List of references

1. Book on Solid Liquid Resource Management – Faecal Sludge Management, Ministry of Drinking Water and Sanitation, Government of India.
2. Faecal Sludge Management (FSM), Sandec Training Tool 1.0 – Module 5 by Department of Water and Sanitation in Developing Countries
3. Methods and Means for Collection and Transport of Faecal Sludge by Georges Mikhael, David M. Robbins, James E. Ramsay and Mbaye Mbéguéré
4. National Policy on Faecal Sludge and Septage Management (FSSM), Ministry of Urban Development, Government of India.
5. Primer on Faecal Sludge and Septage Management, Ministry of Urban Development Government of India.
6. Septage Management, A Practitioner's Guide, Urban India's journey beyond ODF, Ministry of Urban Development, Government of India.
7. Guidelines for Septage Management in Maharashtra, Swachh Maharashtra Mission (Urban) Urban Development Department, Government of Maharashtra
8. Some concepts and definitions, Statistics department.
9. Advisory Note on SEPTAGE MANAGEMENT IN URBAN INDIA, Ministry of Urban Development Government of India.
10. Compendium of Innovative Technologies December 2016 by Indian Institute for human settlement, DEWAT association, Kestone.
11. Faecal Sludge Management: Wadhwan City by Alka Palrecha,Mukta Ramola, Vipashyana Priyadarshini.
12. Compendium of Sanitation Systems and Technologies, 2nd revised edition, Elizabeth Tilley, Lukas Ulrich, Christoph Lüthi,Philippe Reymond and Christian Zurbrügg.
13. Note on Steps for Emptying of Twin Leach Pit Toilet by UNICEF Mumbai
14. An Occasional Report On ODF Sustainability and Water For Sanitation in Maharashtra, Prepared By SIGMA Foundation with Support of UNICEF Maharashtra
15. A report on Status Of ODF Sustainability In The Nagar Panchayats Of Maharashtra by SIGMA Foundation



Supported by:

unicef