

## Lesson Plan: Treatment Technologies



95-110  
minutes

### Lesson Description



This lesson introduces established, transferring, and innovative faecal sludge treatment technologies. These technologies are currently in use for faecal sludge management or could be in the future. Participants learn about the treatment objectives, pathogen inactivation mechanisms, stage of development and treatment products of each technology.

### Learning Outcomes



At the end of this session participants will be able to:

1. List established, transferring, and innovative faecal sludge treatment technologies.
2. Identify the objectives, pathogen inactivation mechanisms, and treatment products of different faecal sludge treatment technologies.

### Materials



- Flip chart paper
- Tape
- Markers
- Scissors
- Glass of dirty water
- Treatment Technologies Table (1 per participant)
- Icon Key (1 per participant)
- Treatment Technologies Table – Solutions (1 per participant)
- Treatment Technology Fact Sheets (1 set)
- Case Studies and Faecal Sludge Management Exercise Book

Optional:

- Activity: What Technology Am I? (1 card per participant)

### Preparation



- Review Chapter 5: Overview of Treatment Technologies in the book *Faecal Sludge Management: Systems Approach for Implementation and Operation*
- Set up four stations for the treatment fact sheets. Tape the fact sheets on the wall or use tables for stations.
  - Dewatering: Settling-thickening, mechanical dewatering, unplanted drying bed, planted drying bed, thermal drying
  - Pathogen inactivation: Co-composting, alkaline treatment, ammonia treatment, storage

- Stabilization/Nutrient management: Deep row entrenchment, incineration, anaerobic digestion, black soldier fly larvae, vermicomposting, vermifilter fish pond, plant pond
- Other: Pelletizing, Co-treatment with wastewater
- Write the heading “*Treatment Technologies*” on flip chart paper
- Write the heading “*Other Factors for Technology Selection*” on flip chart paper
- Print Treatment Technologies Table, Icon Key, and Treatment Technologies Table - Solutions (1 per participant)
- Optional: Print and cut out the cards for the Review Activity: What Technology Am I? (1 card per participant)

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**Introduction**
**5 minutes**

1. Place a cup of dirty water with a lot of solids in front of the participants. Explain that it represents a cup of faecal sludge.
2. Ask participants, “What technologies could be used to treat this?” Record responses on the “*Treatment Technologies*” flip chart. Do not add any missing technologies – these will be introduced later.
  - *Settling-thickening (for example, settling-thickening tanks, settlers, Imhoff tanks, septic tanks)*
  - *Mechanical dewatering (for example, filter press, centrifuge press, belt press)*
  - *Unplanted drying bed (also called sand drying beds)*
  - *Planted drying bed (also called planted dewatering beds, vertical flow constructed wetlands, and sludge drying reed beds)*
  - *Co-composting*
  - *Deep row entrenchment*
  - *Alkaline treatment*
  - *Ammonia treatment*
  - *Incineration*
  - *Anaerobic digestion*
  - *Black soldier fly larvae*
  - *Vermicomposting*
  - *Vermifilter*
  - *Pelletizing (for example, Bioburn pelletizer, LaDePa)*
  - *Thermal drying (for example, solar drying)*
  - *Storage*
  - *Co-treatment with wastewater (for example, anaerobic baffled reactor, waste stabilization ponds, planted gravel filter)*
  - *Fish ponds*
  - *Plant ponds*
3. If applicable, ask, “Are all of these treatment technologies appropriate to treat faecal sludge?” Cross off technologies that are only applicable for wastewater treatment. Explain to participants that treatment technologies designed for wastewater are not necessarily appropriate for treating faecal sludge.
  - *For example, activated sludge process, trickling filter, sequencing batch reactor or anaerobic baffled reactor (this may be suitable for the liquid fraction of faecal sludge after dewatering).*

- *Explain that technologies often fail because they were not designed for the specific characteristics of faecal sludge (presented in the Lesson Plan: Design Approach). If technologies are transferred from wastewater, they will not necessarily work for this reason. Ongoing operation and maintenance (presented in Lesson Plan: Operation and Maintenance) is also important.*
4. Explain that these are some technologies for treating faecal sludge. They have different treatment objectives, treatment products, and level of technology development. More technologies will be introduced in this lesson.
  5. Present the lesson description or learning outcomes.

## Treatment Technologies

65 minutes



1. Tell participants that the following activity is an introduction to faecal sludge treatment technologies. Participants will learn about a treatment technology's objectives, how pathogens are inactivated, and the products. They will also learn the level of technology development (what experience there is with this technology). Tell the participants that they will not be learning about the engineering design details, such as energy, space, and cost. Some technology details are available in the book *Faecal Sludge Management: Systems Approach for Implementation and Operation*.
2. Explain that there are four treatment stations around the room. Each station represents a treatment objective (Dewatering, Stabilization/Nutrient Management, Pathogen Inactivation, Other). At each station there are a number of treatment technology fact sheets.
3. Explain that in pairs, participants will go to the different stations, review the fact sheets and fill out their Treatment Technologies Table. They will have to find out what are the treatment objectives, pathogen inactivation mechanisms, level of development and the treatment products. Participants will have 2 minutes for each technology.
4. Explain that the fact sheets include 2 pages. The first page has images and a brief description of the technology. The second page has more details:
  - *A diagram showing what goes into the treatment technology, the treatment products, and what the treatment products can be used for. This does not mean that the faecal sludge is safe to use. The faecal sludge will require further treatment depending on the use. Note: sludge is described as liquid, dewatered or dry.*
  - *A rating of all treatment objectives.*
    - *Pathogen inactivation and dewatering are rated as low, medium or high.*
    - *Stabilization / nutrient management is listed as "yes" or "no".*
    - *The main treatment objective is rated as "high". A less important objective is rated as "medium". If there is a minor treatment objective, it is rated as "low".*
  - *A list of the different pathogen inactivation mechanisms.*
    - *Storage (or time) – refers to the combination of three different mechanisms: age, predation and starvation. It's difficult to separate which of these mechanisms are inactivating pathogens within the treatment technologies.*

- *Dehydration – removing the moisture*
- *UV light – ultraviolet light or solar radiation*
- *Temperature*
- *pH*
- *The level of development: innovative, transferring, and established.*
  - *Established technologies have been designed and implemented specifically for faecal sludge.*
  - *Transferring technologies have been adapted from wastewater treatment or another sector such as animal feed or biomass fuel production.*
  - *Innovative technologies are currently being researched, developed, and piloted.*



5. Hand out the Treatment Technologies Table and an Icon Key to every participant. Ask participants to go to a treatment technology poster in their pairs. There should be one pair at each poster. After 2 minutes, ask the pairs to move to the next treatment technology. After all the participants have completed all the treatment factsheets, ask them to return to their seats.
6. Ask participants, “Do all technologies have the same treatment objectives?”
  - *No, treatment technologies have different treatment objectives. Some treatment objectives focus only on dewatering (for example, settling tanks, unplanted drying beds). Some technologies focus only on pathogen inactivation (for example, lime treatment). Some treatment technologies have several treatment objectives (for example, Co-composting).*
7. Ask participants, “Which treatment technologies inactivate pathogens to a safe level?”
  - *There are no technologies that inactivate pathogens to a safe level. Ammonium and alkaline treatment do inactivate pathogens, but these are transferring technologies that have not been widely implemented in faecal sludge management. Co-composting also focuses on pathogen inactivation by increasing temperature, but it is difficult to reach high temperatures. More research is required.*
8. Ask participants, “Do all treatment technologies have the same options for use?”
  - *No, treatment technologies produce different treatment products. Some treatment technologies produce stabilized sludge, dewatered sludge or dry sludge. Others produce protein, biofuels, or effluent for irrigation. Some treatment technologies can produce a treatment product which can be used in several markets. For example, unplanted drying beds produce sludge which can be used as a soil conditioner for agriculture or forestry, a biofuel or to produce building materials.*
9. Ask participants, “Are all technologies well established?”
  - *No, some are established, but some are transferring technologies and others are innovative technologies that require more research.*
10. Explain that to effectively treat faecal sludge, several treatment technologies may be needed in a particular order. Explain that usually you will first need to dewater and then stabilize and inactivate pathogens. Give a few examples.



- *To compost liquid sludge, you will first need to dewater the sludge and then compost it.*
  - *To use faecal sludge from a pit latrine to grow edible crops, you can't just use vermicomposting because it doesn't inactivate pathogens to a high level. You will probably need to co-compost, use additives or simply store the faecal sludge for a longer period of time.*
  - *To use faecal sludge to make briquettes, you need dry sludge that has not been stabilized. You may need to dewater faecal sludge and then dry it.*
11. Tell the participants that besides these technical factors (such as, treatment objective, treatment product, level of technology development) many other factors influence the choice of technologies. Ask participants, "What factors may influence the selection of a treatment technology?" Record responses on "*Other Factors for Technology Selection*" flip chart.
- *Cost*
  - *Environmental factors (for example, soil type, climate, groundwater level, geography)*
  - *Local resources (for example, human and financial resources)*
  - *Power requirements (such as, consider how electricity shortages will impact the operation of the technology)*
  - *Space availability*
  - *Land requirements*
  - *Economic considerations*
  - *Legal regulations*
12. Explain that some these other factors will be further discussed during the workshop and that these are all critical components of an integrated planning approach (for example, legal framework)
13. Refer participants to Chapter 5 of the book *Faecal Sludge Management: Systems Approach for Implementation and Operation* for more information about technologies. See the planning and management sections of the book for other important design variables to consider.

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### Optional: Risk Management

**5 minutes**



1. Explain that there are several barriers that can be put in place to avoid the spread of faecal pathogens when managing a treatment facility.
2. Ask participants to stand up if their barrier can reduce this risk (see Lesson Plan: Risk Management). Ask them to explain why.
3. Ask participants, "Are there any other barriers that could be put in place when managing a treatment facility?"
  - Use protective equipment
  - Restrict access
  - Monitoring
  - Effluent management

- Siting
- Keep site clean
- Handwashing
- Cleaning tools
- Training

**Exercise Book****10 minutes**

1. Handout the Treatment Technologies Table – Solutions to each participant.
2. Ask the case study groups to return to their Exercise Book and complete Section 5: Faecal Sludge Treatment Technologies. Groups will list their treatment objectives, select treatment technologies and create a treatment process.

**Optional Review Activity: What Technology Am I?****10 minutes**

1. Tape one “What Technology Am I?” card to the back of every participant. Explain that the objective is to identify which treatment technology they have on their back by asking others only yes or no questions. Provide an example of a yes/no question. Explain that participants can only ask one question to each person. When the participants have guessed their treatment technology, take the card off of their back and give them another card. Continue the activity for 5 minutes










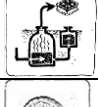

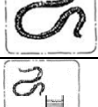
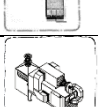
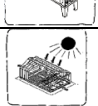


**Review****5 minutes**

1. Ask participants to find a partner from another case study group. Ask participants to share the treatment process their group recommended and why.




**Reflections on Lesson**






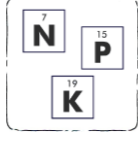



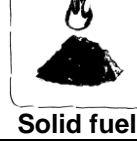

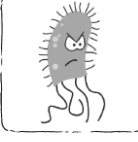
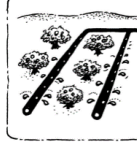


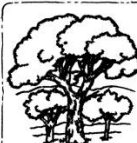
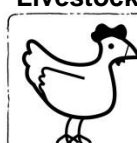
**Activity: Treatment Technologies Table**

	Treatment technology	Treatment objectives	Treatment products	Pathogen inactivation mechanisms	Level of technology development
	Settling-thickening				
	Mechanical dewatering				
	Unplanted drying beds				
	Planted drying bed				
	Co-composting				
	Deep row entrenchment				
	Alkaline treatment				
	Ammonia treatment				
	Incineration				
	Anaerobic digestion				
	Black soldier fly larvae				
	Vermicomposting				
	Vermifilter				
	Pelletizing				
	Thermal drying				
	Storage				






















	Treatment technology	Treatment objectives	Treatment products	Pathogen inactivation mechanisms	Level of technology development
	Co-treatment with wastewater				
	Fish pond				
	Plant pond				

**Activity: Icon Key**

Treatment objectives	Use	Level of technology development
<b>Dewatering</b> 	<b>Agriculture, horticulture</b> 	<b>Established</b> 
<b>Nutrient Management</b> 	<b>Biogas</b> 	<b>Transferring</b> 
<b>Stabilization</b> 	<b>Solid fuel</b> 	<b>Innovative</b> 
<b>Pathogen Inactivation</b> 	<b>Irrigation</b> 	
	<b>Aquaculture</b> 	
	<b>Construction (building materials)</b> 	
	<b>Forestry</b> 	
	<b>Livestock</b> 	

**Activity: Treatment Technologies Table – Solutions**


	Treatment technology	Treatment objectives	Treatment products	Pathogen inactivation mechanisms	Level of technology development
	Settling-thickening	Dewatering	Liquid sludge Effluent with pathogens	Storage	Established
	Mechanical dewatering	Dewatering	Dewatered sludge with pathogens Effluent	None	Transferring
	Unplanted drying beds	Dewatering	Dewatered or dry sludge with pathogens Effluent	Dehydration UV light Storage	Established
	Planted drying bed	Dewatering Stabilization/Nutrient management	Plants Dry stabilized sludge with pathogens Effluent	Dehydration UV light Storage	Established
	Co-composting	Pathogen inactivation Stabilization/Nutrient management	Dewatered stabilized sludge with low pathogens Effluent	Temperature Storage	Established
	Deep row entrenchment	Stabilization/Nutrient management	Plants Trees	Storage	Established
	Alkaline treatment	Pathogen inactivation	Liquid/Dewatered sludge with low pathogens	pH	Transferring
	Ammonia treatment	Pathogen inactivation	Liquid sludge with low pathogens	Complex reactions (more research required)	Innovative
	Incineration	Pathogen inactivation Dewatering Stabilization/Nutrient management	Ash Biofuel	Temperature	Transferring
	Anaerobic digestion	Stabilization/Nutrient management	Liquid stabilized sludge with / without pathogens Biogas	Storage	Transferring
	Black soldier fly larvae	Stabilization/Nutrient management	Dewatered stabilized sludge with pathogens Black soldier fly larvae	Storage	Innovative
	Vermicomposting	Stabilization/Nutrient management	Dewatered stabilized sludge with pathogens Effluent	Storage	Innovative / Transferring
	Vermifilter	Stabilization/Nutrient management	Dewatered stabilized sludge with pathogens Effluent	Storage	Innovative / Transferring
	Pelletizing	Pathogen inactivation (when combined with another technology)	Dried sludge pellets	None	Transferring
	Thermal drying	Dewatering Pathogen inactivation	Dry sludge with pathogens	Temperature Dehydration Storage	Transferring
	Storage	Pathogen inactivation	Dry sludge with low pathogens	Storage	Established

	Treatment technology	Treatment objectives	Treatment products	Pathogen inactivation mechanisms	Level of technology development
	Co-treatment with wastewater	Depends	Treated effluent	Depends	Transferring
	Fish pond	Stabilization/Nutrient management	Fish Liquid sludge Effluent with pathogens	Storage	Innovative / Transferring
	Plant pond	Stabilization/Nutrient management	Aquatic plants Liquid sludge Effluent with pathogens	Storage	Innovative / Transferring

## Review Activity: What Technology Am I?



<b>Co-composting</b>	<b>Vermicomposting</b>
<b>Black Soldier Fly Larvae</b>	<b>Planted Drying Bed</b>
<b>Unplanted Drying Bed</b>	<b>Thermal Drying</b>
<b>Thermal Drying</b>	<b>Mechanical Dewatering</b>
<b>Alkaline Treatment</b>	
<b>Ammonia Treatment</b>	<b>Pelletizing</b>
<b>Incineration</b>	<b>Anaerobic Digestion</b>
<b>Settling-Thickening</b>	<b>Deep Row Entrenchment</b>

<b>Fish Pond</b>	<b>Plant Pond</b>
 <b>Vermifilter</b>	