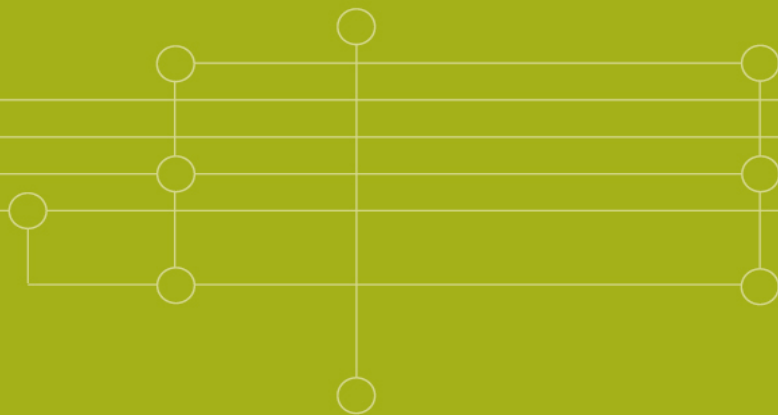
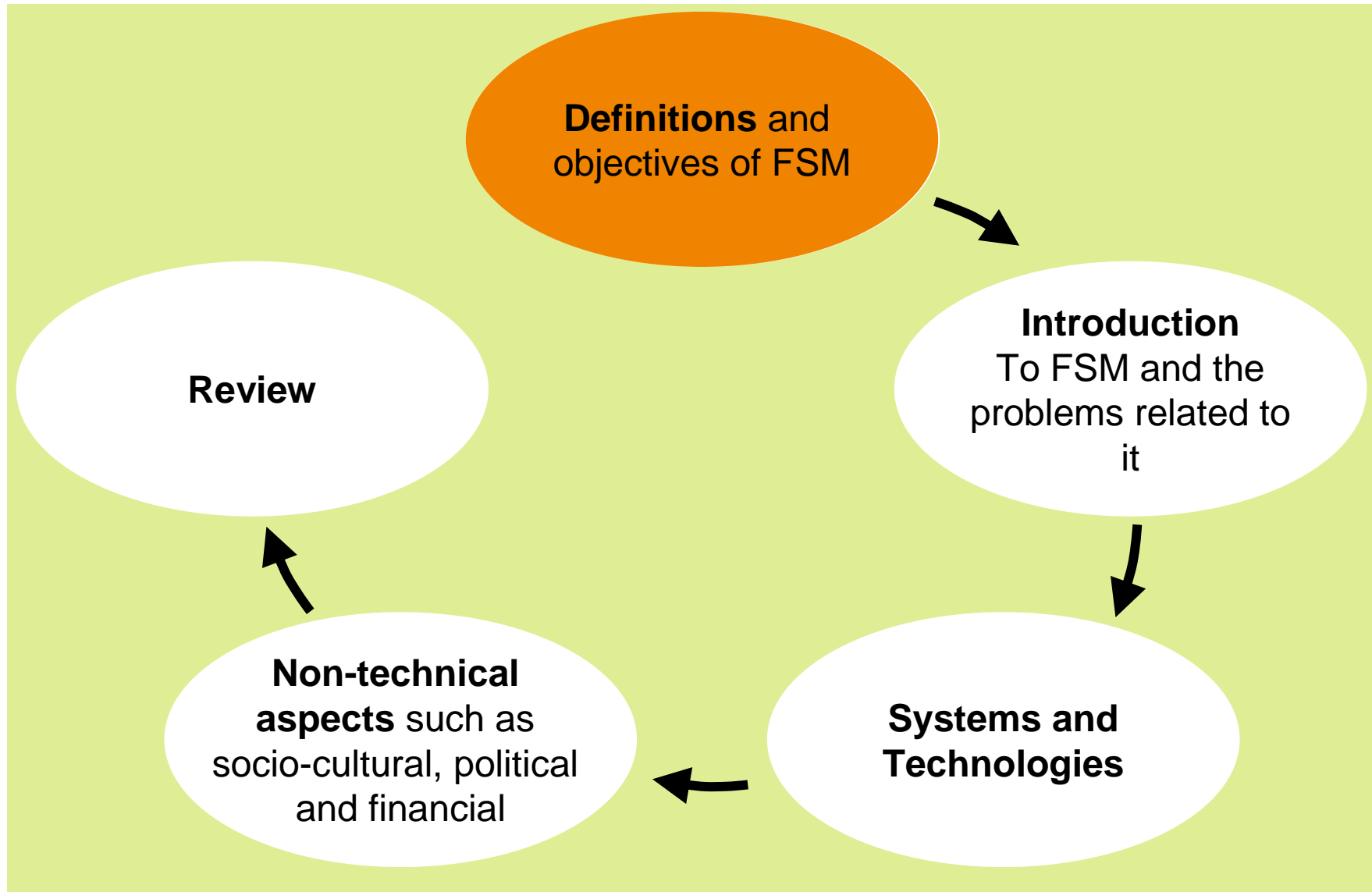


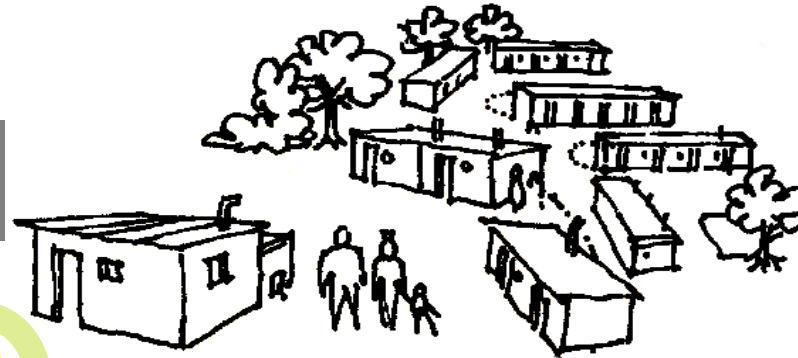
Sandec Training Tool 1.0 – Module 5

Faecal Sludge Management





What is our focus in this course?



Water supply

Sources of waste

Houshold water handling

Sanitation

Waste generation

Drainage

Wastes
Resources

Greywater

Wastewater

Excreta,
Faecal sudge

Solid Waste

Stormwater

Processes

Storage – Transport – Treatment – Disposal – Reuse

Management

Planning – Financing – Implementing
Operation & Maintenance – Regulation & Enforcement

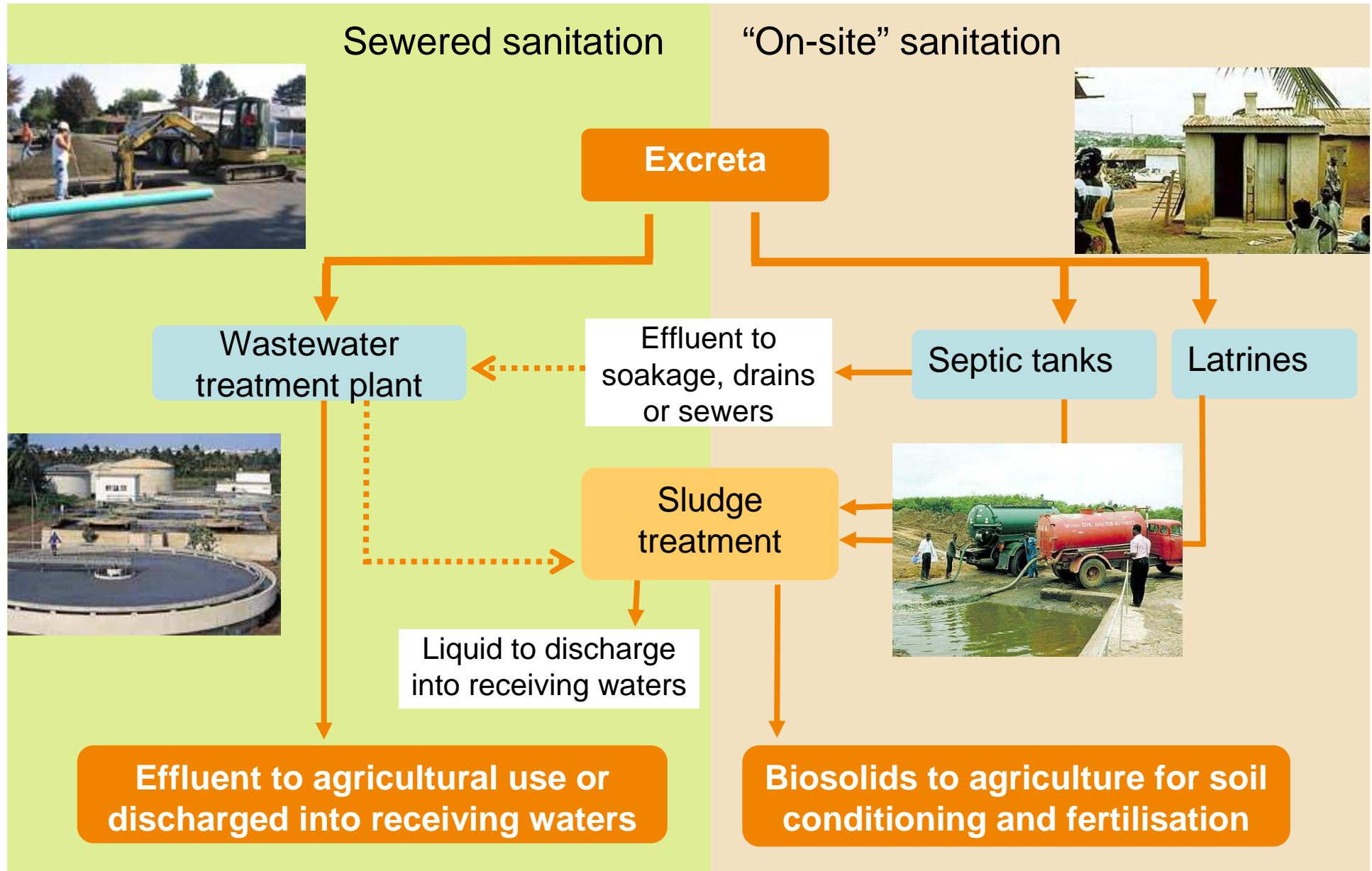
What is Faecal Sludge Management? (FSM)?

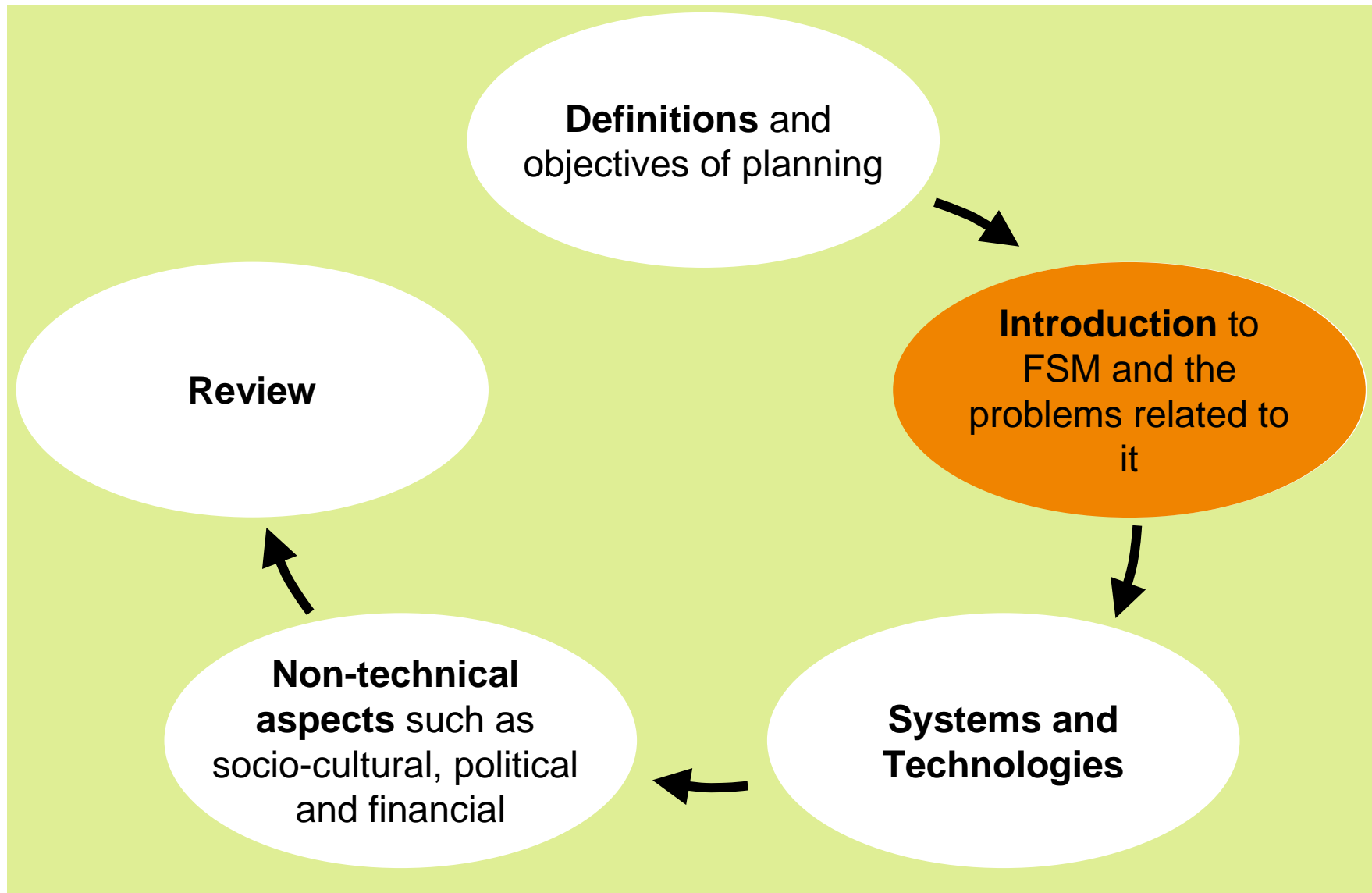
- Faecal Sludge Management deals with the management of sludges from on-site sanitation systems, while wastewater management deals with sewerage sanitation. Faecal sludge may be treated in separate treatment works or co-treated with sludges produced in wastewater treatment plants.

Definitions

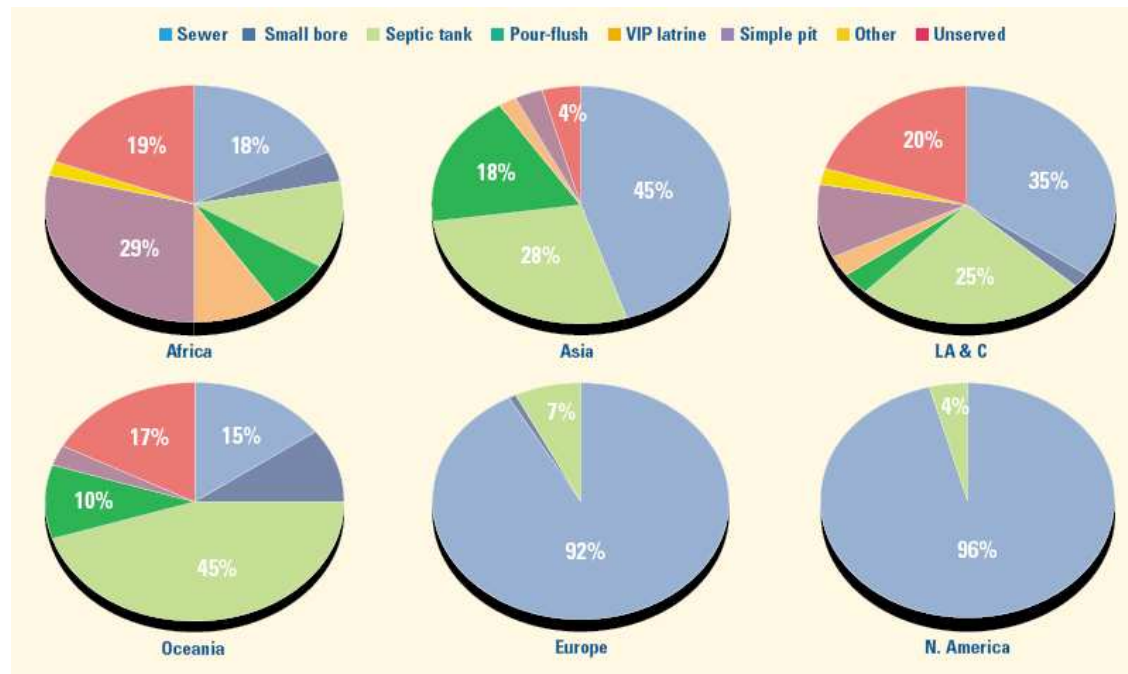
- Cesspit An enclosed container used for storing sewage.
- Combined Sewer A sewer system that is designed to carry both blackwater from homes and stormwater (rainfall). Combined sewers must be much larger than Separate Sewers to account for the high volume.
- Faecal Sludge Is the general term for the undigested or partially digested slurry or solid that results from the storage or treatment of blackwater or excreta
- Faeces Refers to (semi-solid) excrement without any urine or water
- Septage Liquid and solid material pumped from a septic tank, cesspool or other primary treatment source.
- Sewage General name given to the mixture of water and excreta (urine and faeces), although more technically it should be referred to as blackwater.
- Sewer An open channel or closed pipe used to conveying sewage
- Sewerage All the components of a system used for collecting, transporting and treating sewage (including pipes, pumps, tanks, etc.)
- Sludge The thick, viscous layer of materials that settles to the bottom of septic tanks, ponds, and other sewage systems. Sludge is comprised mostly of organics, but also sand, grit, metals, and various chemical compounds.
- Sullage Old word for greywater: includes wastewater from cooking, washing, and bathing, but does not include any excreta.

“On-site” vs. sewered FS management



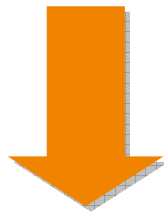


Sanitation in the largest cities: Mean percentage for each type of sanitation system, by world region



Problems related to FSM

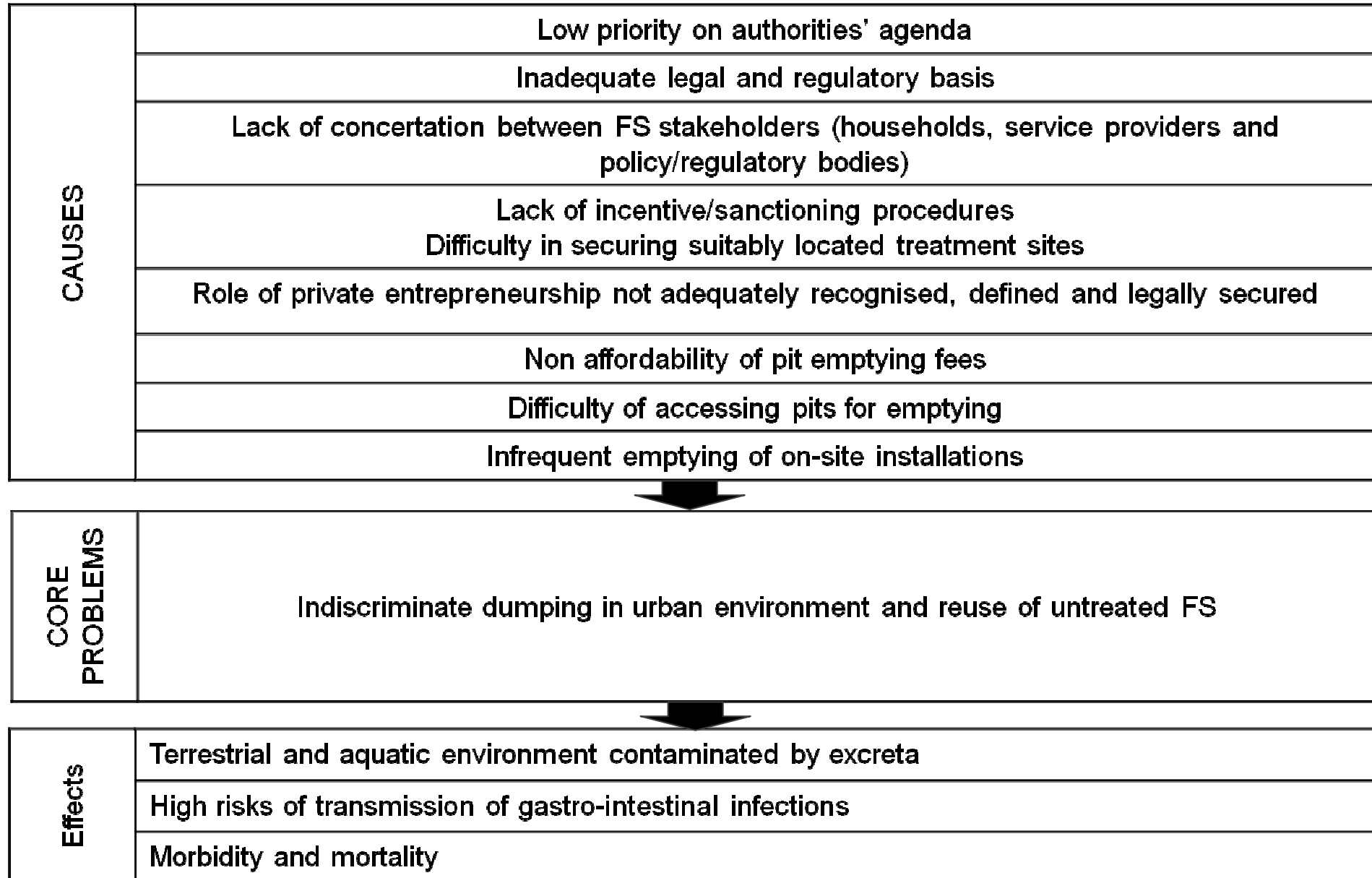
- Manual emptying of pits, septic tanks etc.
- Indiscriminate disposal
- No or inadequate treatment



- Contamination of soil and water
- Health hazards



What are the causes for the present situation?



Which parameters are used to characterise FS?

pH

TS

EC

TVS

TKN

AN



C/N

Heavy metals

Helminth eggs

FC (MPN)

BOD/COD

What are the daily per capita quantities for FS?

Parameter	Septage ¹	Public toilet sludge ¹	Pit latrine sludge ²	Fresh excreta
BOD [g/cap·day]	1	16	8	45
TS [g/cap·day]	14	100	90	110
TKN [g/cap·day]	0.8	8	5	10
Volume [l/cap·day]	1	2 (includes water for toilet cleansing)	0.15 - 0-20	1.5 (faeces and urine)

1 Estimates are based on a faecal sludge collection survey conducted in Accra, Ghana.

2 Figures have been estimated on an assumed decomposition process occurring in pit latrines. According to the frequently observed practice, only the top portions of pit latrines (~ 0.7 ... 1 m) are presumed to be removed by the suction tankers since the lower portions have often solidified to an extent which does not allow vacuum emptying. Hence, both per capita volumes and characteristics will range higher than in the material which has undergone more extensive decomposition.

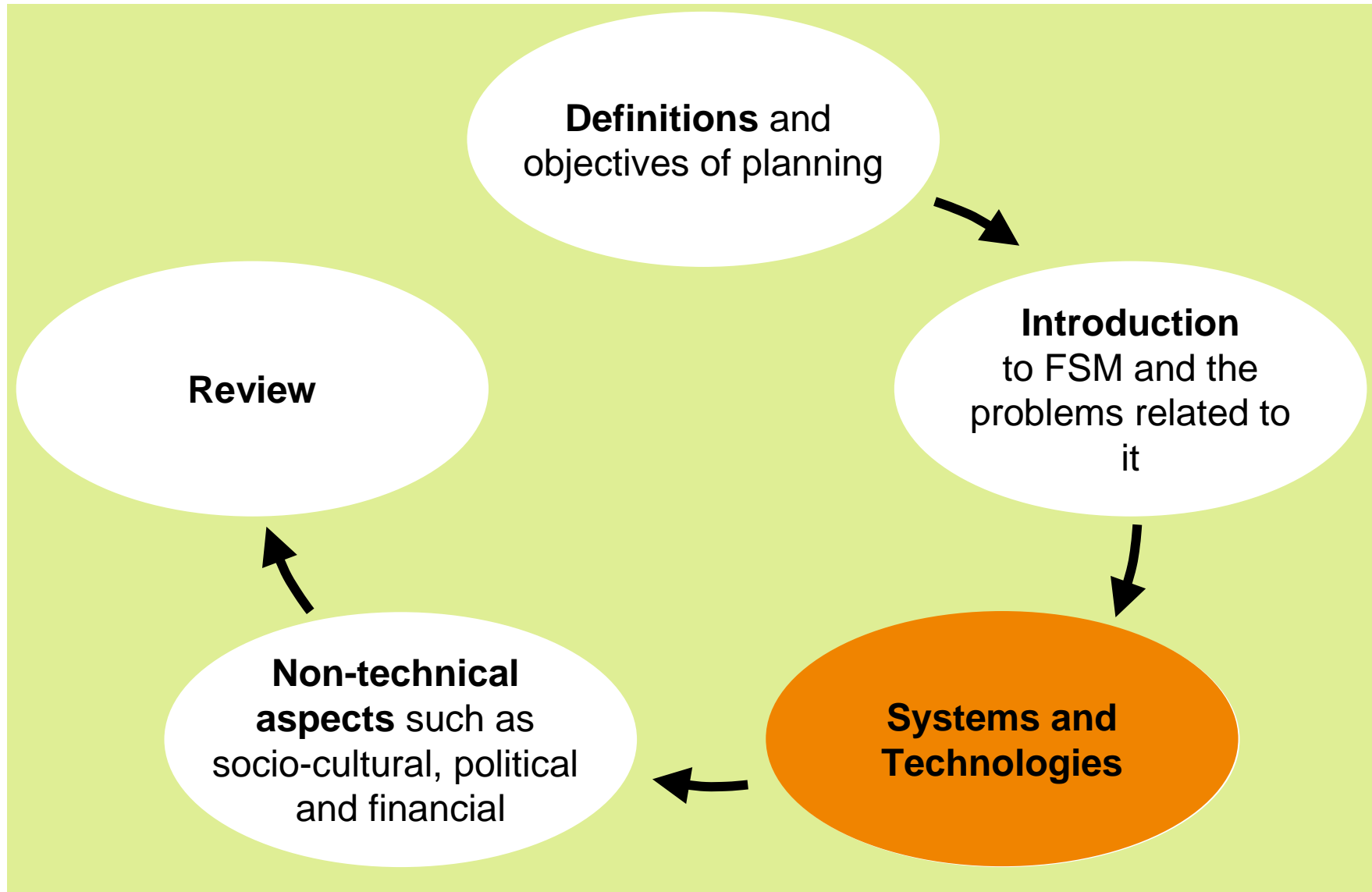
What is the hygienic quality of FS?

	Ascaris [eggs/gTS]	Trichuris [eggs/gTS]
<i>Public toilet sludge</i>		
Sample 1	13	2
Sample 2		9
<i>Septage</i>		
Sample 3	3	2
Sample 4	94	24
Sample 5	29	15

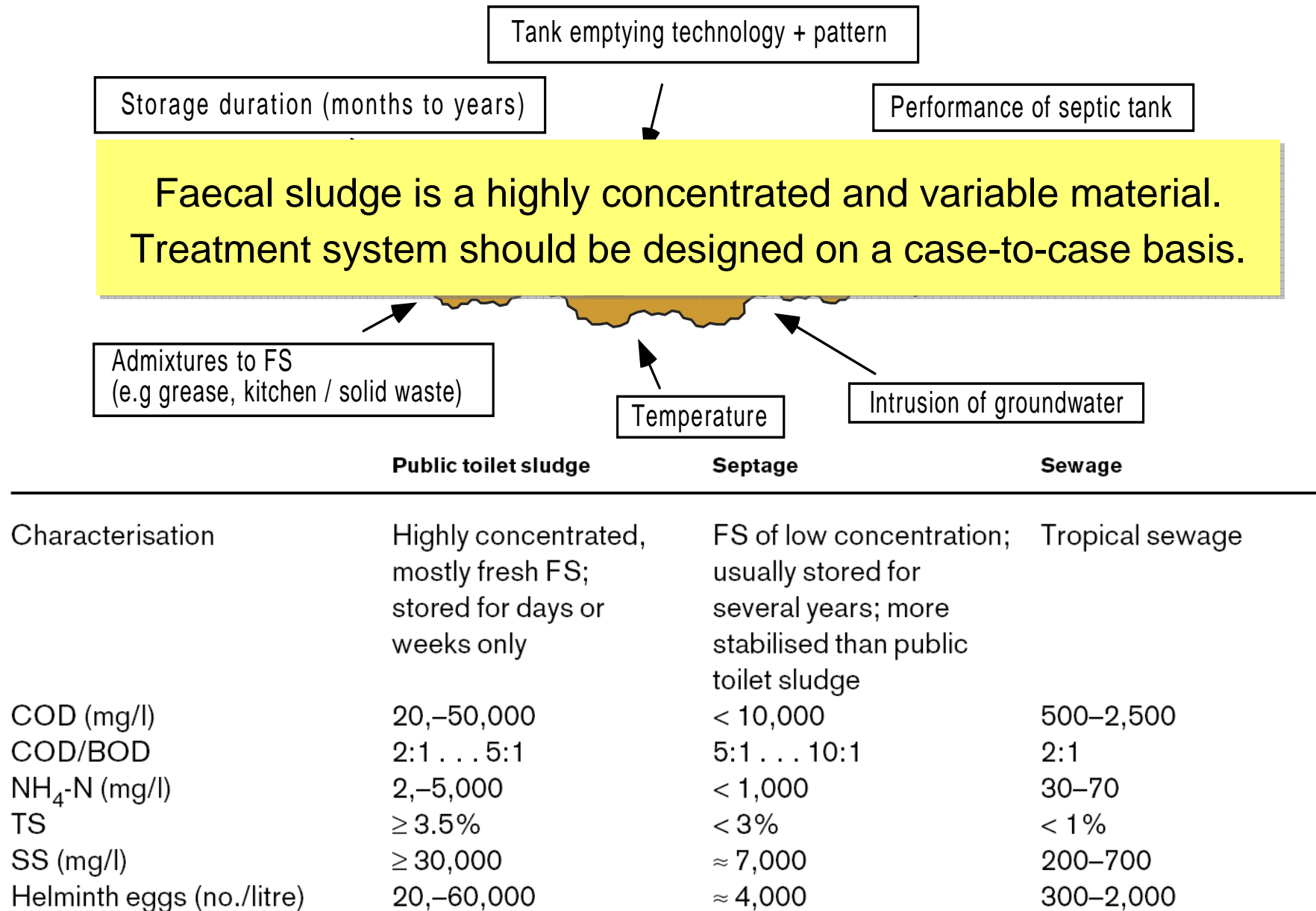
Prevalence of Ascaris and Trichuris eggs in Kumasi's (Ghana) raw faecal sludge

About effluent standards for FS treatment plants

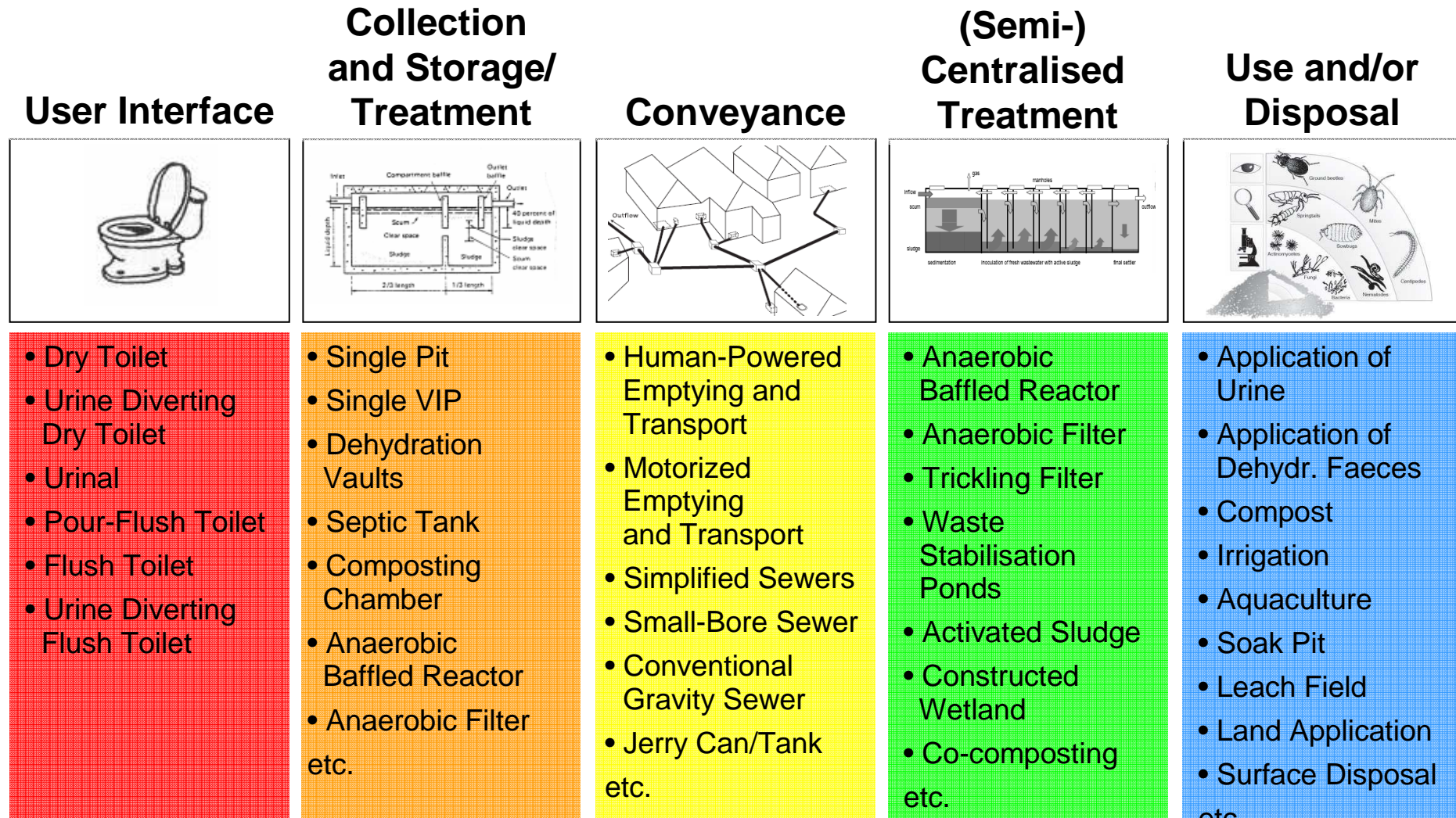
- In economically less advanced countries, the development of monitoring and enforcement systems is still lagging far behind and is more difficult to organize and implement than in industrialized countries.
- Replicating the strict standards or limits established in industrialized countries without taking into account the regional characteristics or necessary data pertaining to the local conditions is therefore entirely inappropriate.
- In many instances, the numerical values of certain parameters are established without defining locally appropriate management and treatment options for wastewater and biosolids.



What influences the character of Faecal Sludge?

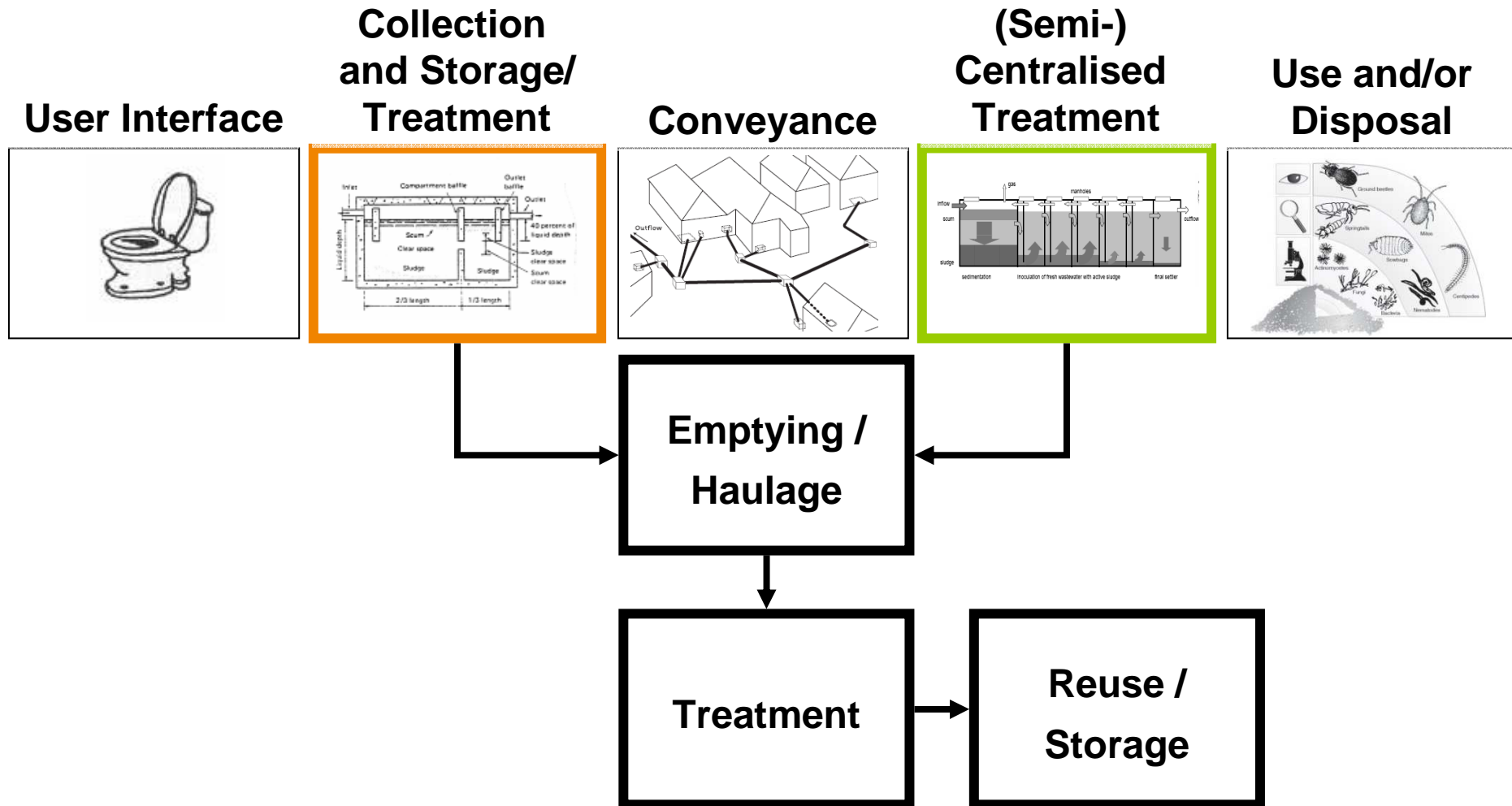


What are the processing steps (functional groups) and technologies in sanitation?



Only selected combinations of technologies will lead to functional systems.

What are the process steps in FS management?



What are the main options for pit emptying and FS transport?

- Manual emptying
 - The waste/sludge is emptied by hand using buckets and shovels
 - A portable, manually operated pump system (e.g. MAPET)
- Mechanical emptying
 - e.g. Vacutag

Manual emptying



MAPET



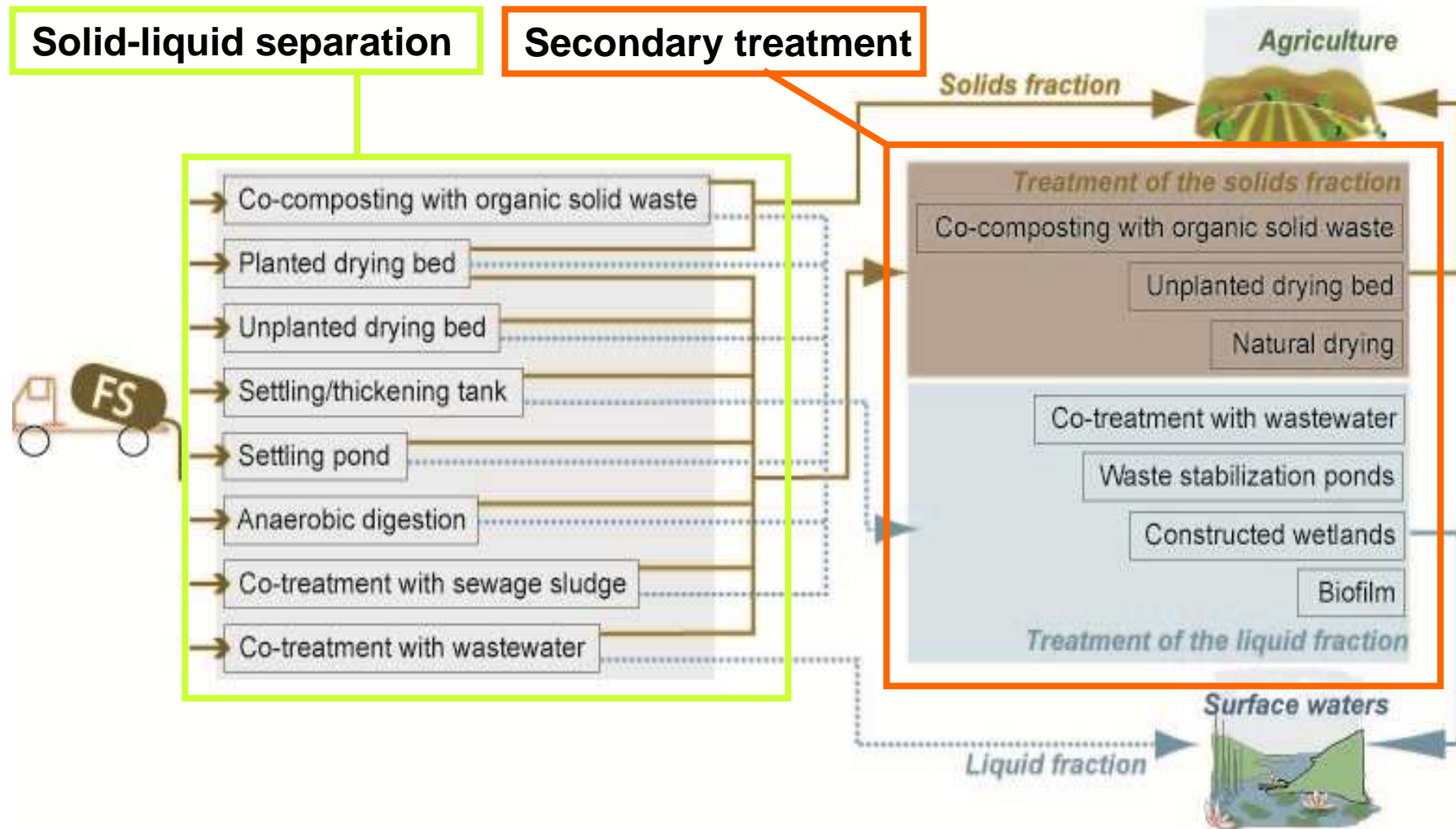
Vacutag



Comparison of manual emptying vs. mechanical emptying

	Manual Emptying	Mechanical Emptying
Advantages	<ul style="list-style-type: none"> + Accessibility + Local job creation and income generation 	<ul style="list-style-type: none"> + Fast, and generally efficient + Minimizes health risk
Disadvantages	<ul style="list-style-type: none"> - Time consuming - Health hazard for workers - Hard, unpleasant work - MAPET requires some specialized repair (welding) - Requires a disposal point or discharge area (< 0.5 km) - Spillage and bad odors 	<ul style="list-style-type: none"> - Low accessibility - Expensive capital and O&M costs (which is passed onto the customers) - Can not pump thick, dried sludge (must be manually removed) - Pumps usually only suck down to a depth of 2-3 m

What are the major technologies for solid-liquid separation and FS treatment?



Co-composting

Municipal solid waste



Mixing ratio:
1:2 to 1:10

Faecal sludge



Thermophilic
Co-composting

50-60 ° C is
effective for
pathogen
destruction



90 days is long
enough for the
inactivation of all
helminth eggs.

valuable soil
conditioner-
cum-fertilizer

Safe reuse in agric.



Planted drying bed

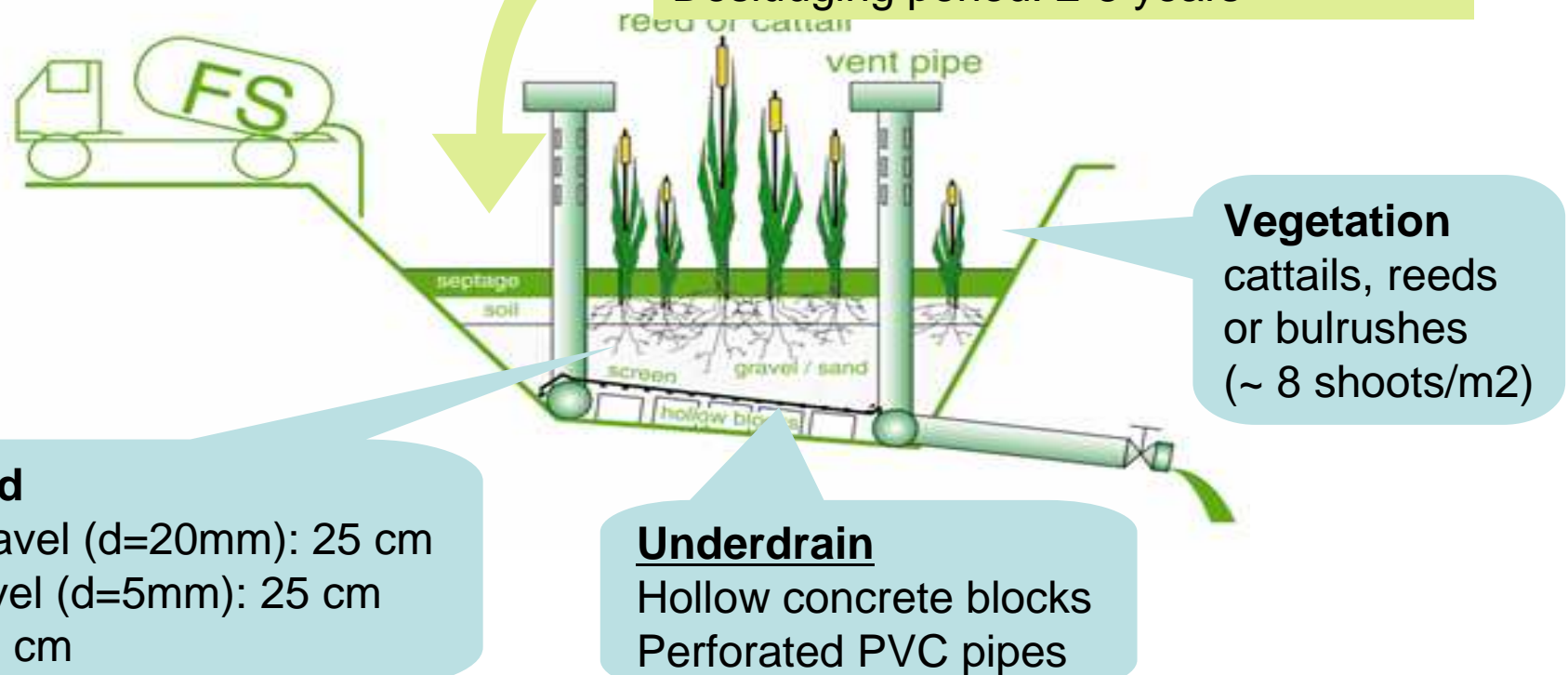
Land requirement:
 ~ 0.03 m²/cap

Operation

Application rate: up to 250 kg/m²/year

Application frequency: 1-2/week

Desludging period: 2-3 years



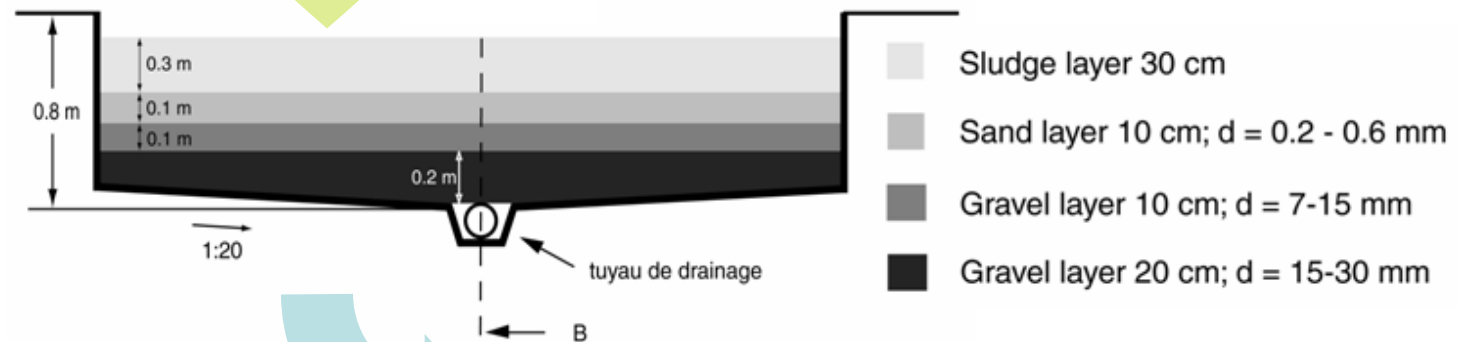
Percolate and biosolids usually need further treatment

Depends on sludge contamination and local discharge regulations

Unplanted drying bed

Sludge application depth: ~25-30 cm

TS loading: ~100-200 kg TS/m²*a



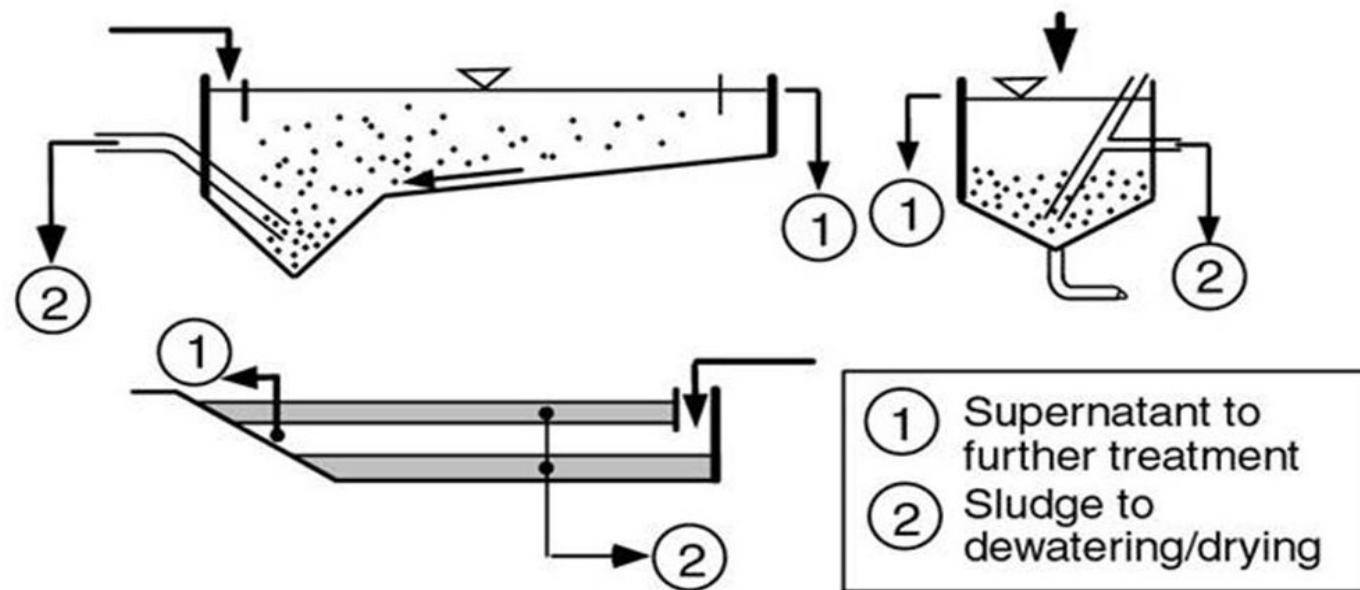
Percolate quantity: ~50-80% of FS volume

Drying period to attain 40% solids content: ~8-12 days (dry weather)

Land requirement: ~ 0.05 m²/cap (assuming a 10-day cycle)

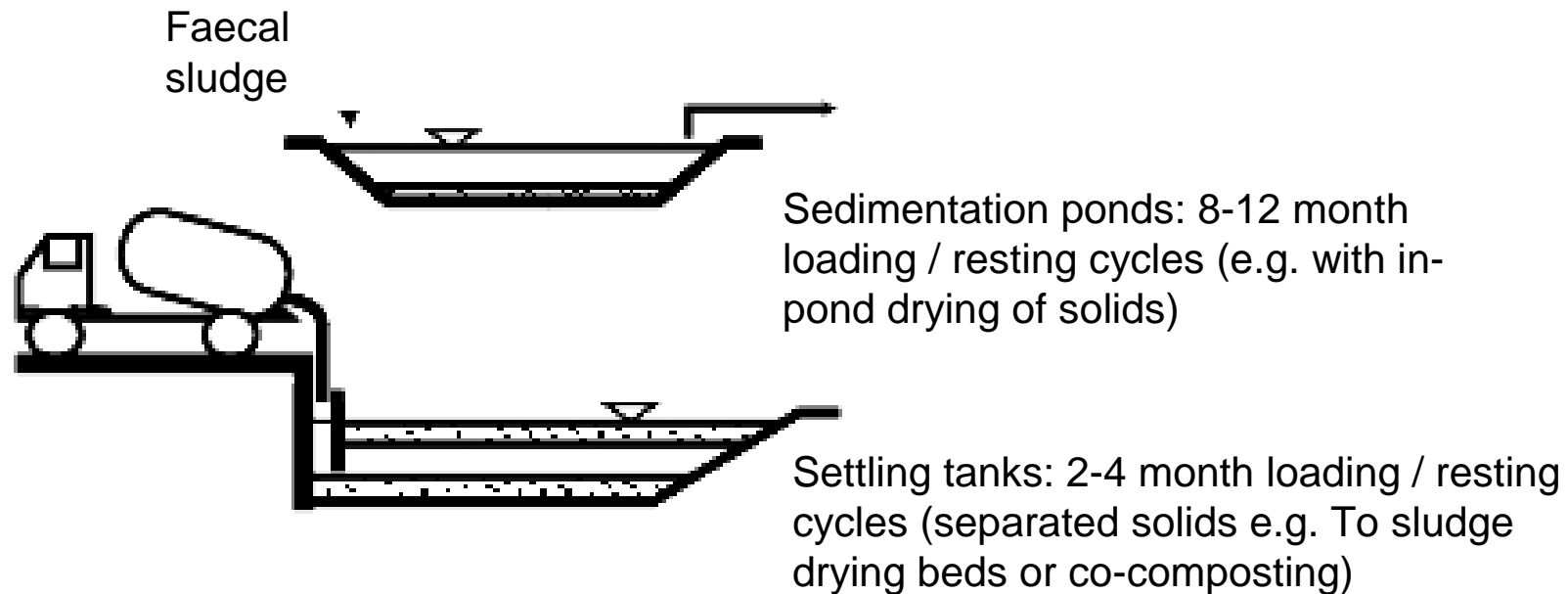
Both, percolate and biosolid need further treatment !

Settling/thickening tanks



- Settling/thickening units operated alternatively (e.g. 4 weeks loading / 4 weeks drying)
- Performance of the tanks strongly depends on the plants state of maintenance and operation
- Problem when treating fresh public toilet sludges: bad settling behavior!

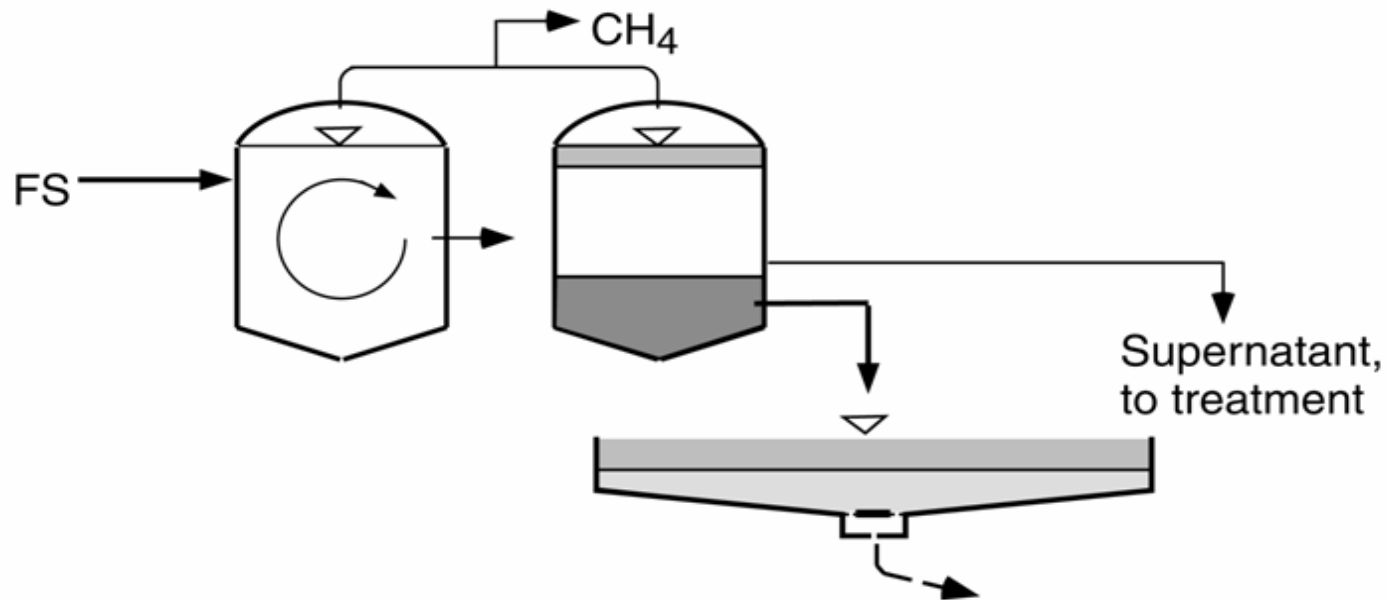
Comparison of sedimentation/settling ponds vs. settling tanks



Characterization	Settling-thickening tanks	Settling ponds
Suspended solids (SS)	60%	> 95%
BOD and COD (unfiltered)	3 –50%	70–95%
BOD (filtered)	18%	45%

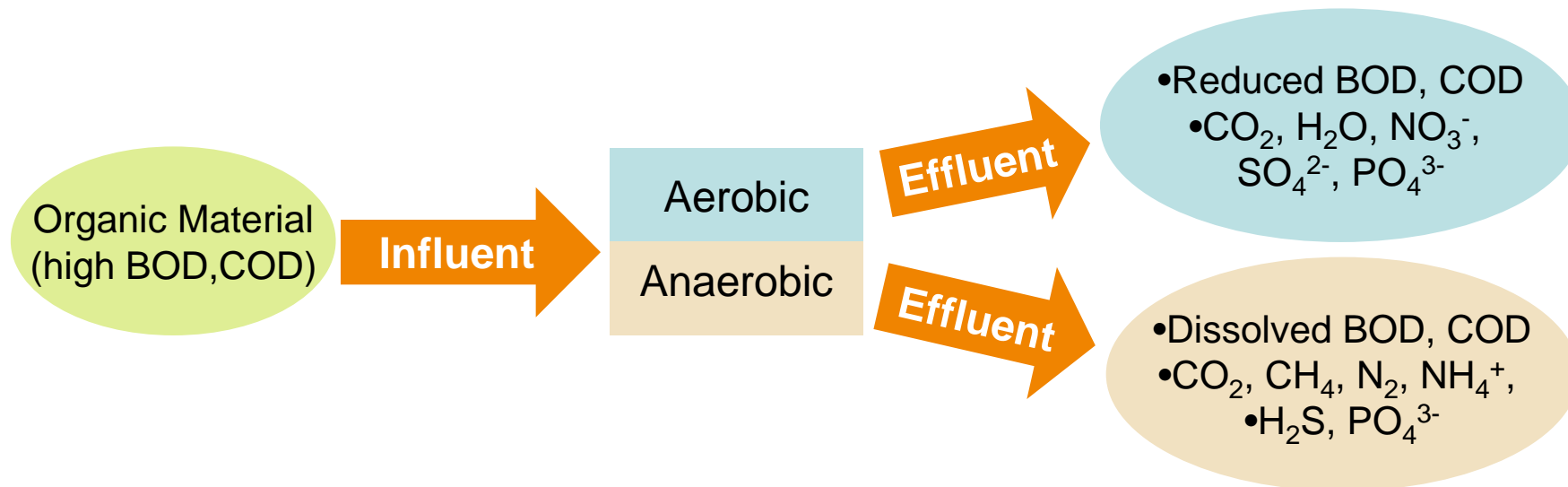
Anaerobic digestion

Anaerobic Digestion



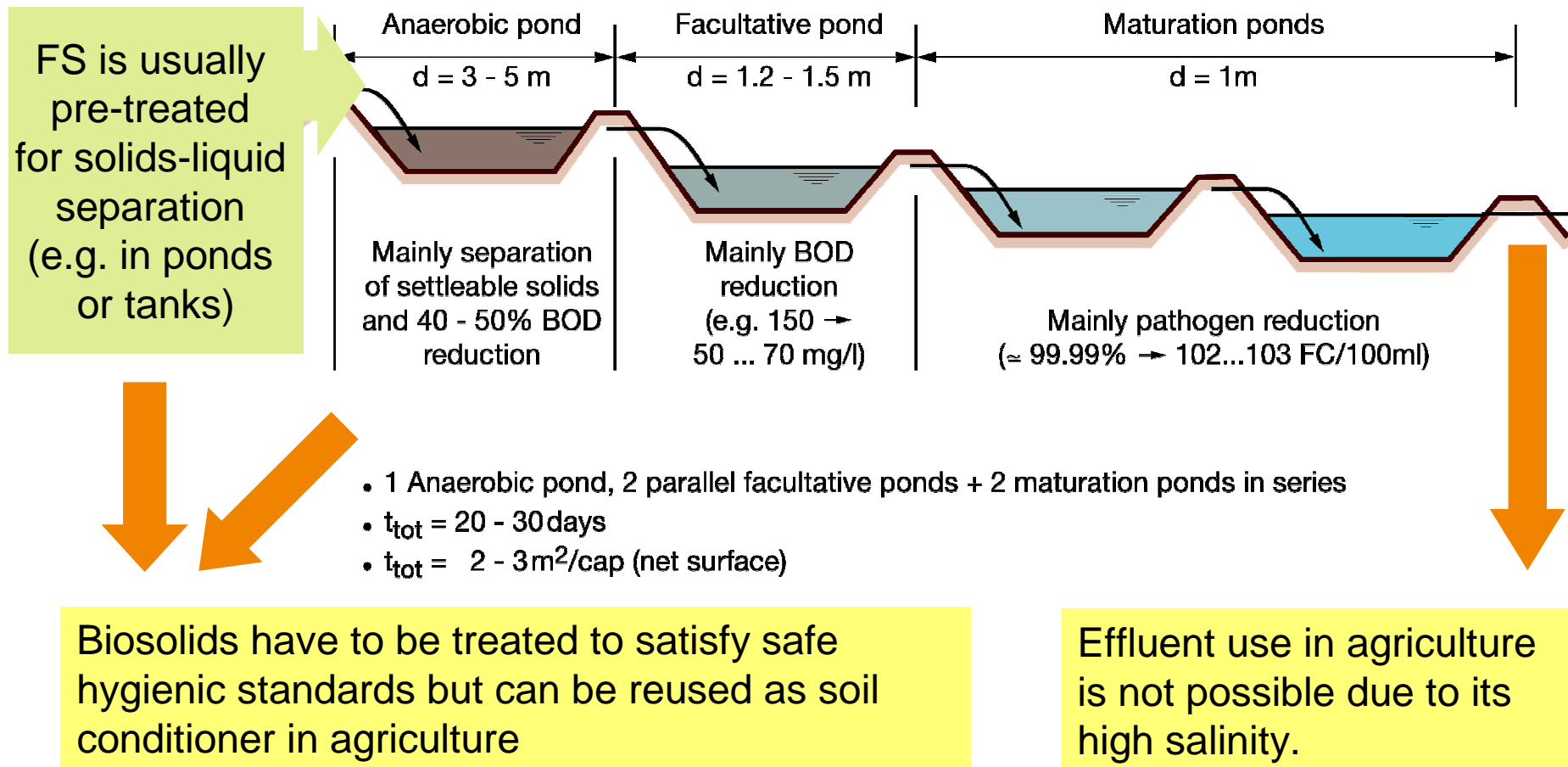
- + Biogas extraction → energy production, light, cooking
- Mechanization level higher than for e.g. pond systems
- Higher operation and maintenance requirement

Anaerobic vs. Aerobic digestion



	Aerobic	Anaerobic
Example of Application	Trickling Filters, Oxidation Ponds	Anaerobic Reactor
Carbon Balance	50% CO ₂ 50% Biomass	95% CH ₄ +CO ₂ (=Biogas) 5% Biomass
Energy Balance	60% Biomass 40% Heat production	90% Retained in CH ₄ 5% Biomass 5% Heat production
Biomass Production	Fast	Slow

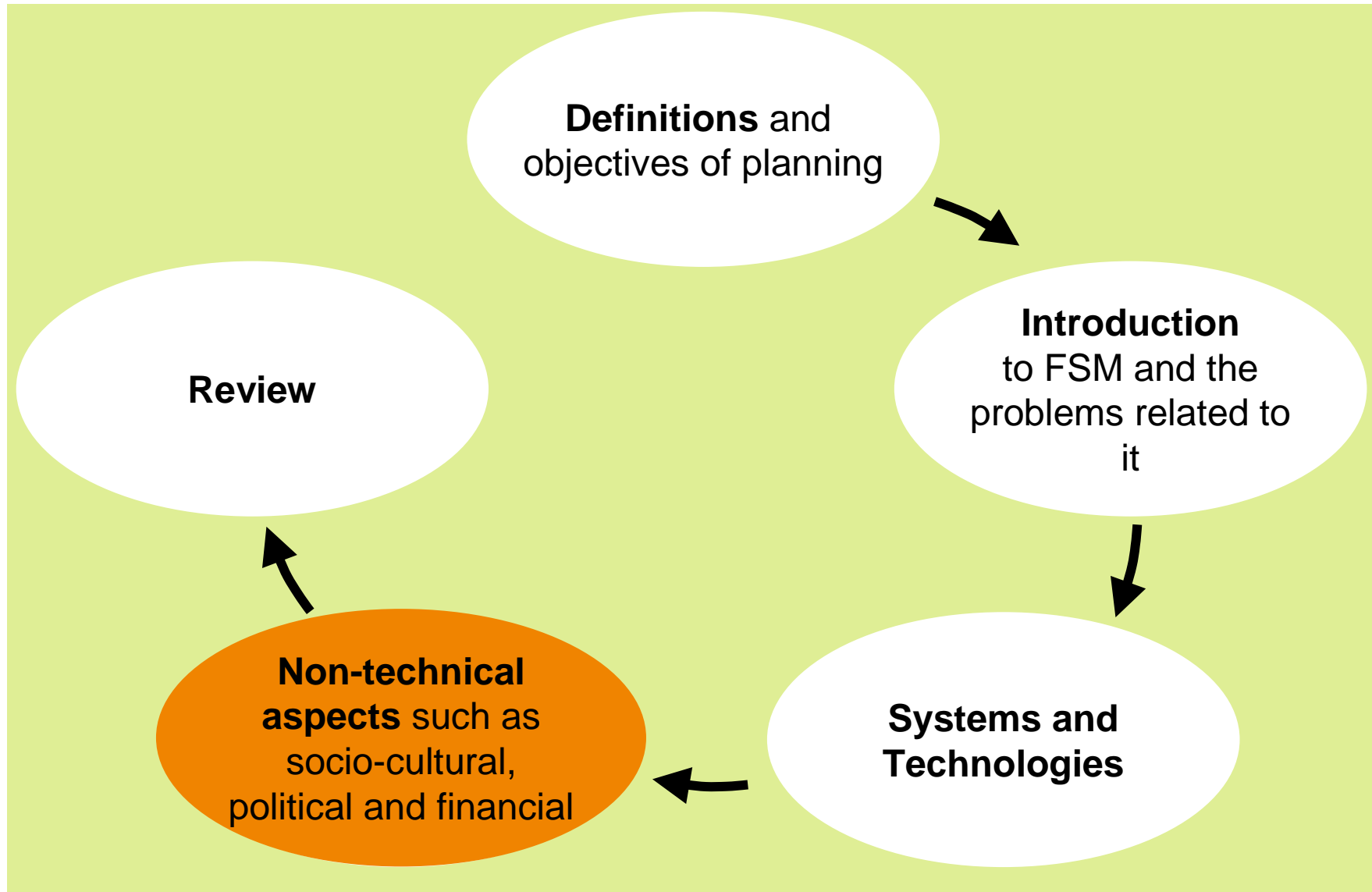
Waste stabilisation ponds



FS co-treatment with wastewater

Problems with Waste-Stabilization Ponds:

Variable	Effects and expected problems
SS	<ul style="list-style-type: none"> - Sludge settling and consolidation → More frequent solids removal and handling → Short-circuiting of flow
NH₄ / NH₃	<ul style="list-style-type: none"> - Ammonia toxicity due to high concentration in undigested FS. → Inhibition to the development of facultative and maturation pond conditions - Eye irritation
Colouration	<ul style="list-style-type: none"> - Dark colour of FS supernatants prevents light penetration → Algal growth and hence facultative or maturation pond conditions may not evolve



Who are the stakeholders in faecal sludge management and what are their roles and challenges?

- The community
- Governmental decentralized services
- CBOs
- NGOs
- Authorities
- Public utilities
- Private sector members
- Donors

How to select the most appropriate FS treatment option?

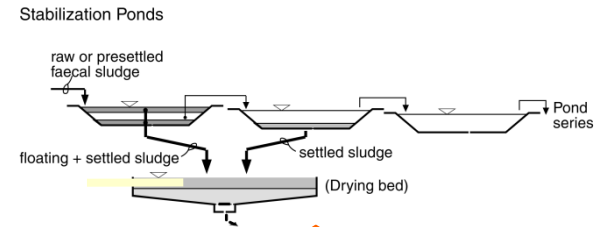
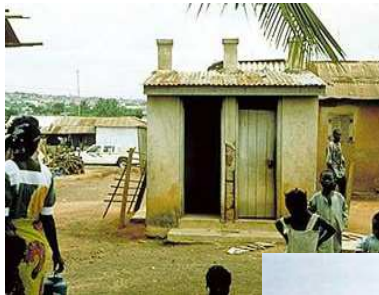
- 1. Step: Pre-screening of options deemed to be unsuitable, based on a detailed situation assessment
- 2. Step: Comparison of potentially feasible options
- 3. Step: Weighing of the different criteria and determination of the most appropriate option

What are financial and economic costs?

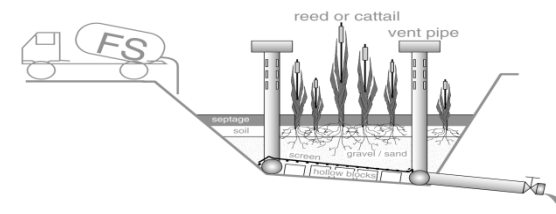
Financial cost



Economic cost



Constructed Wetlands



Cost relevant only for individual household, enterprise or institution. e.g. Price charged to household for pit emptying

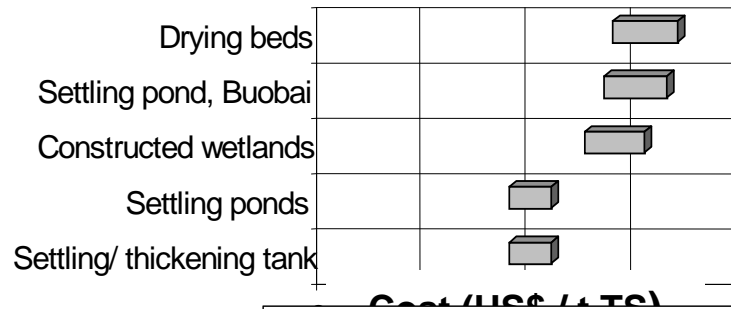
Unit: e.g. \$ or \$/year

Cost shaped to allow accounting and comparison of treatment plants and management systems.

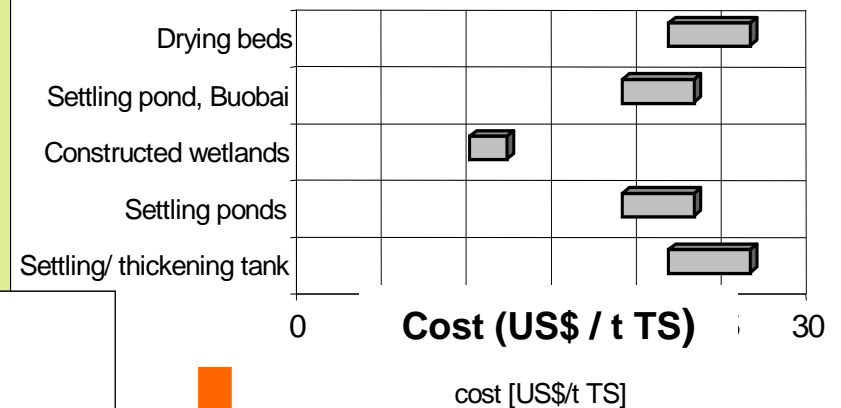
Unit: e.g. \$/ton TS treated in one year

How can different FS treatment technologies be economically evaluated and compared?

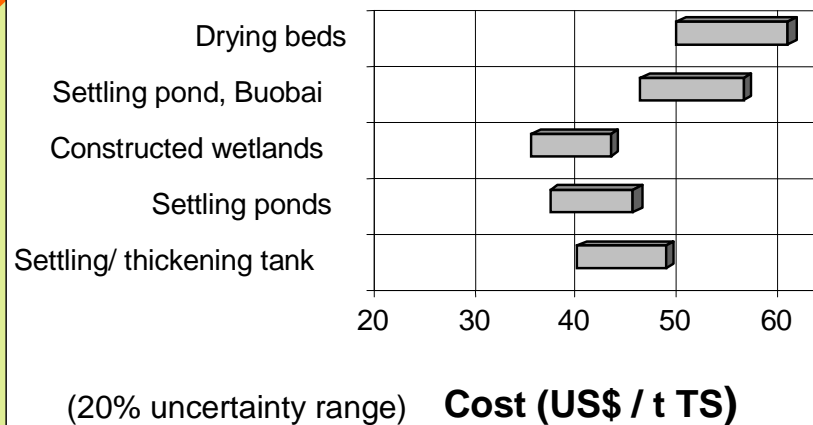
Annualized capital cost



Annualized O&M cost



Total annual cost

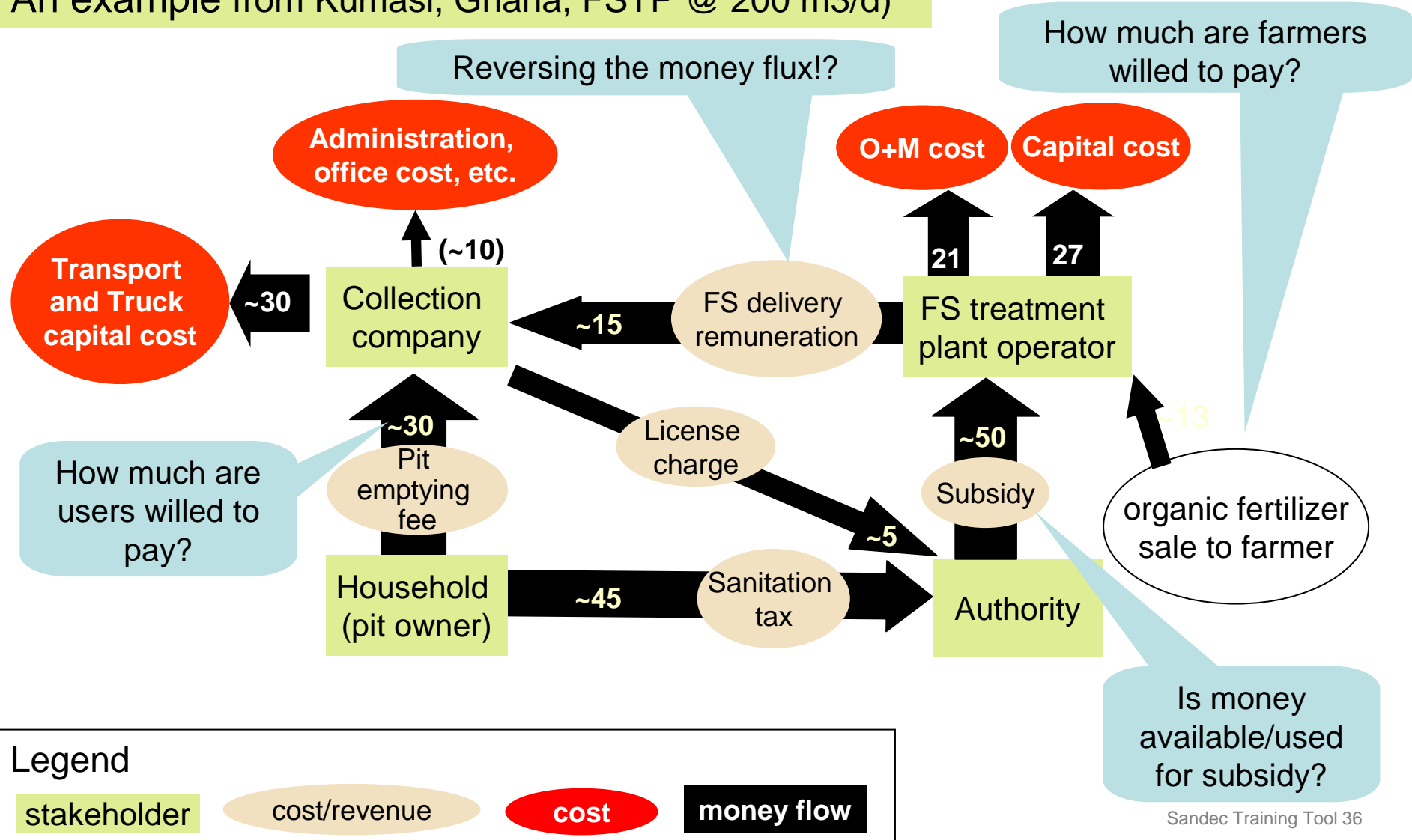


- All costs scaled to standard plant capacity (here 500 t TS/yr)
- compare only plants with similar quality of effluent!

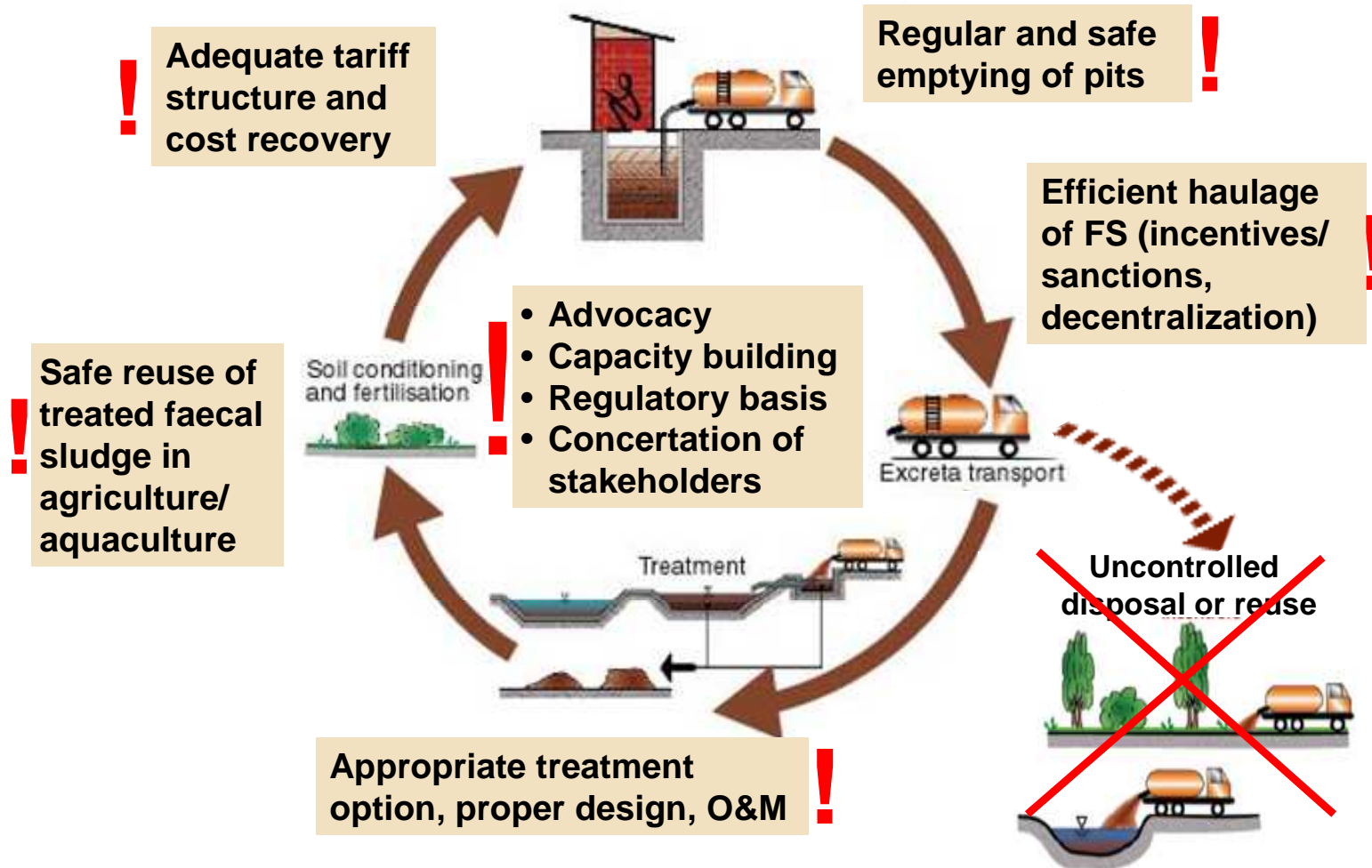
Costing examples of FS treatment alternatives in Kumasi, Ghana

What has to be considered when designing a financing scheme for sanitation systems?

An example from Kumasi, Ghana, FSTP @ 200 m³/d

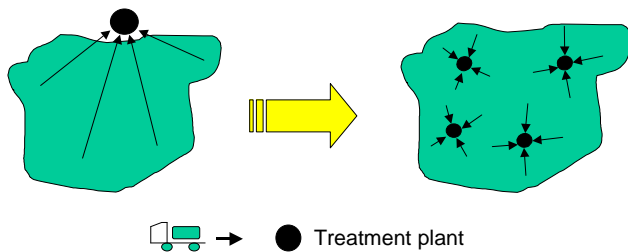


How can FS management be improved?



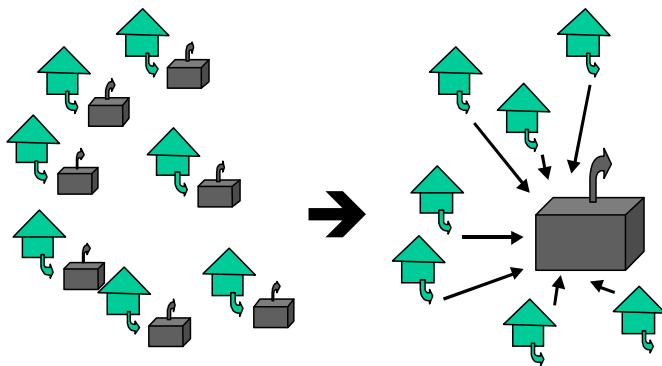
Decentralization of FS haulage

Scale: centralized or semi-centralized ?



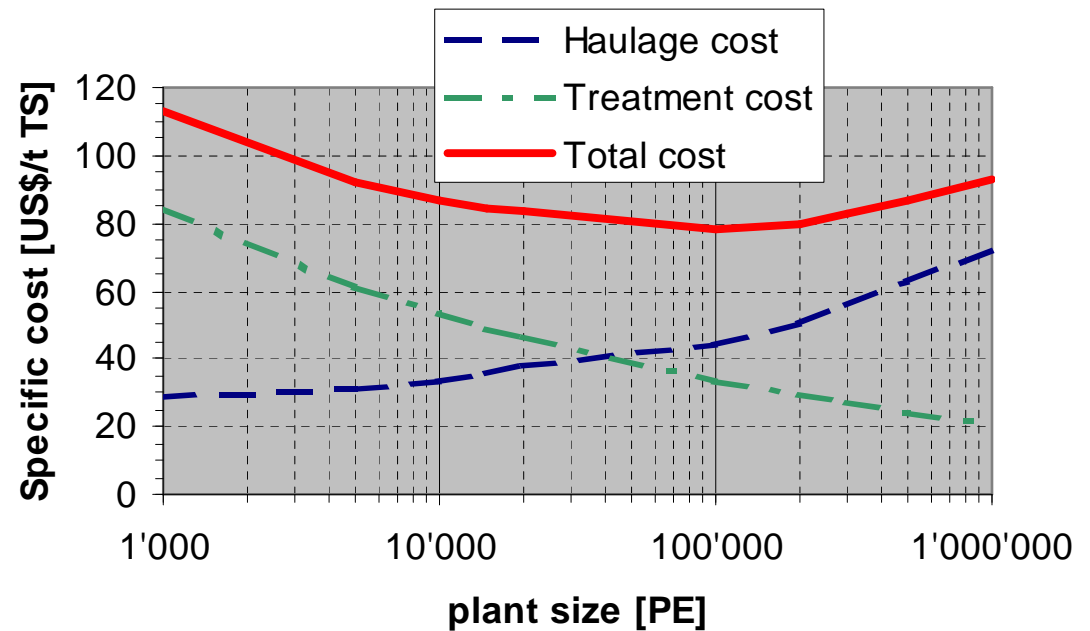
→ Minimize overall management (transport + treatment) cost (raw FS, separated solids, liquid effluent)

Communal instead of individual septic tanks



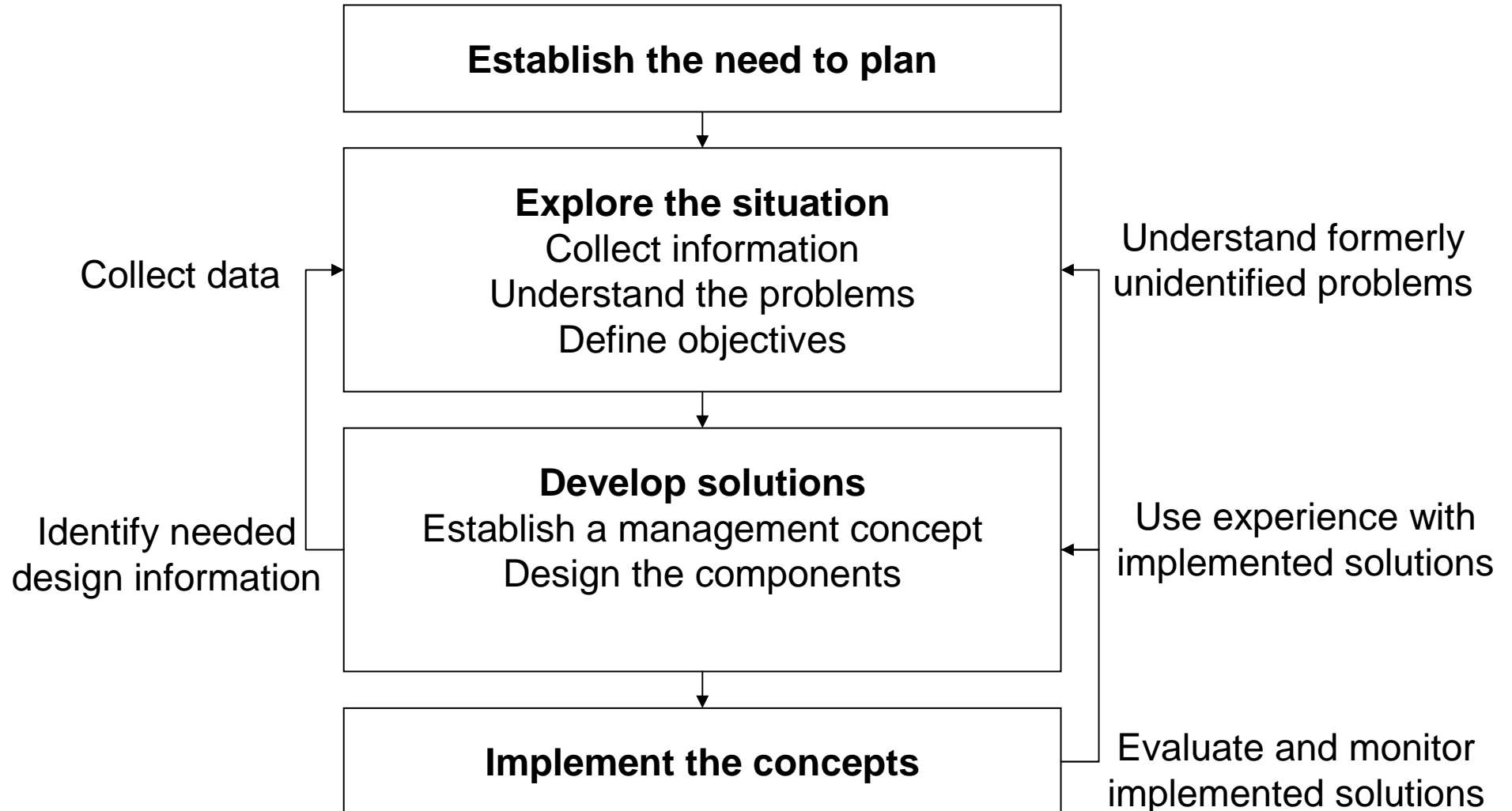
→ Minimizes emptying trips (km x m³)
→ Improves access to septic tanks

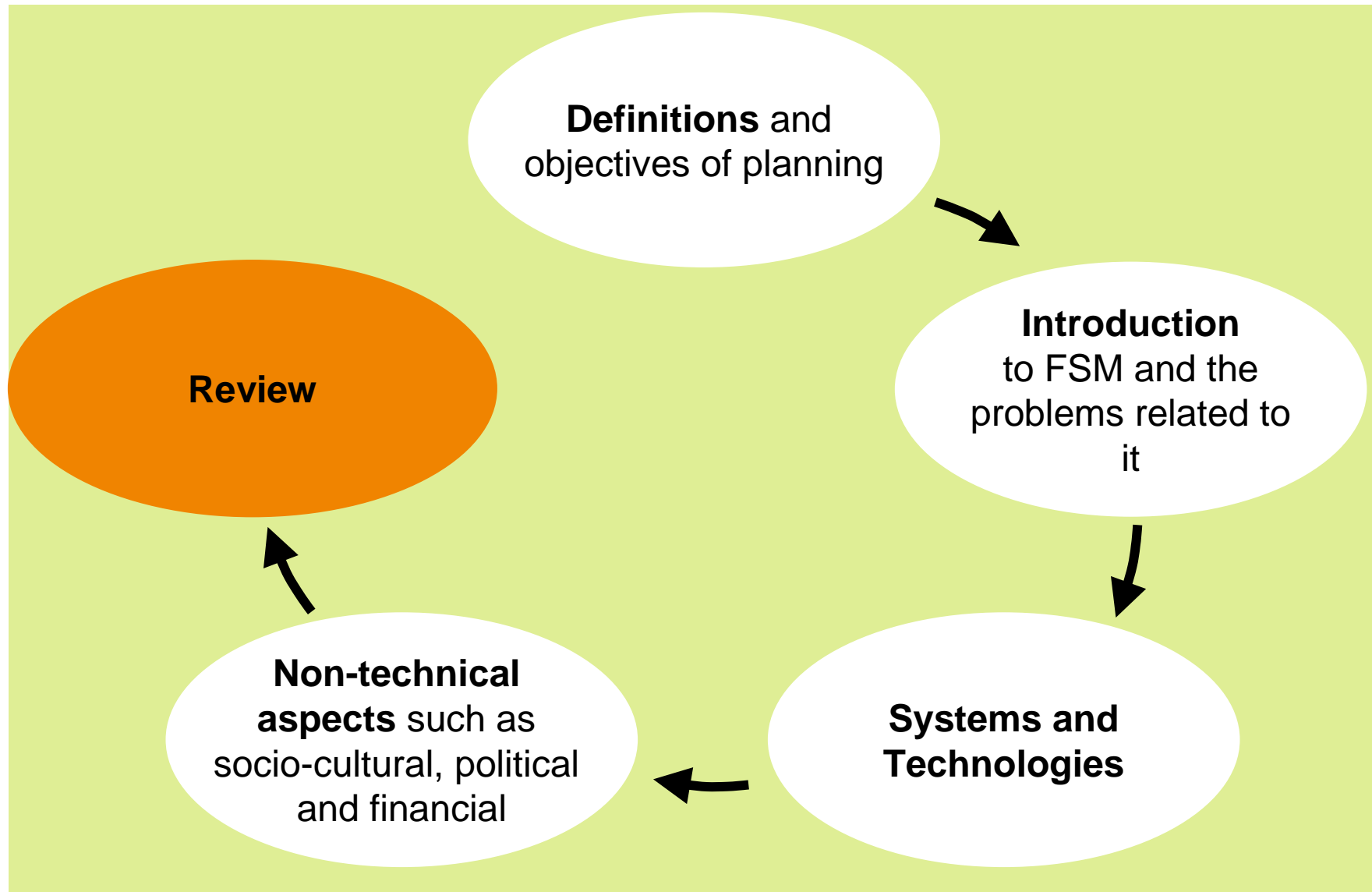
Annual haulage (with additional distance*) and treatment cost per t TS in fonction of plant size



How to plan for improved FS management?

Stages in the planning process





Review

- FS management deals with the management of sludges from on-site sanitation systems
- FS may be treated in separate treatment works or co-treated with sludges produced in wastewater treatment plants
- On-site sanitation (OSS) systems are the predominant form of excreta treatment installations in urban centres of industrializing countries.
- Faecal sludge management has to cope with a number of challenges, namely health threats posed by manual emptying of pits, indiscriminate disposal and by no or inadequate treatment of sludges.

Credits

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