PRESENTATION:
CE 4412 LECTURES

ONSITE SANITATION AND FAECAL SLUDGE MANAGEMENT

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Objectives

- Introduce students to OSS
- Introduce students to FSM

Definition

- A system where the treatment of excreta or sewage or wastewater takes place at the site of generation

- It is also referred to as decentralised sanitation

Significance

- Appropriate system where the per capita investment in terms of off-site is too high (Example-farm areas with spaced housing units)
- Also may be the only feasible sanitation means in poor communities (In poor countries)
- In Lusaka, over 70% of the population is in peri-urban areas where more than 90% are on pit latrines
- Most of the other areas are on septic tanks
- Sewered area may be less than 20%

On-site Sanitation Systems

- Conventional On-Site Systems (Drop and Store)
- Resource Oriented Sanitation - ROSA (Ecological Sanitation)

Types of Conventional On-site Systems

- Simple Pit Latrines
- Ventilated Improved Pit (VIP) latrines
- Water flush toilets connected to septic tanks
- Aqua-privies
- Cesspools
- Cartage or Conservancy or bucket Latrines

Conventional Pit Latrines

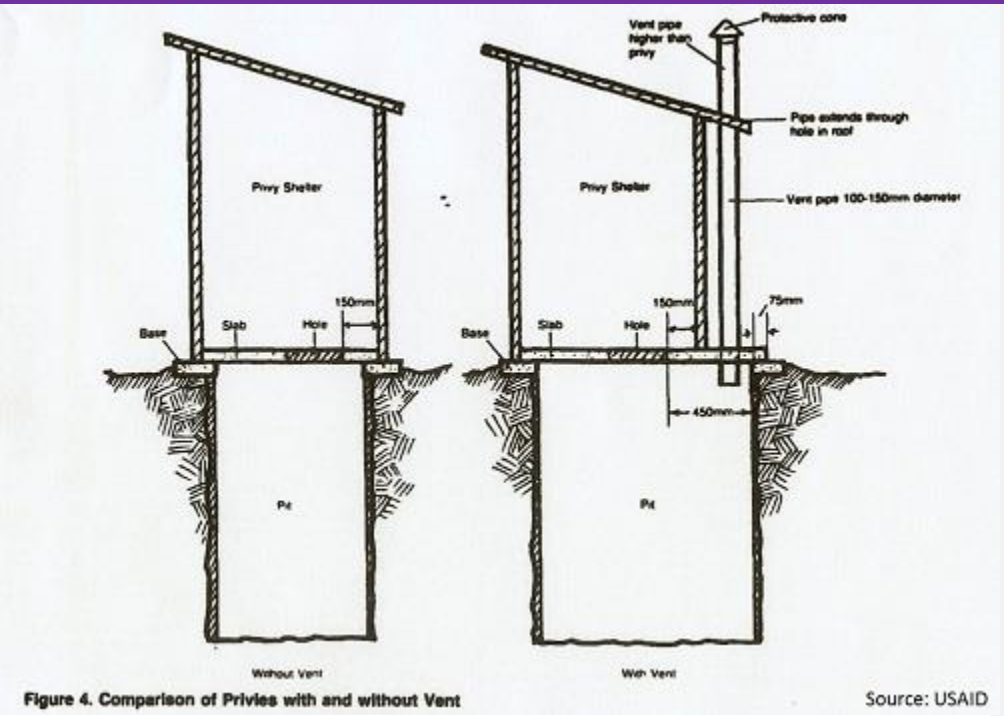


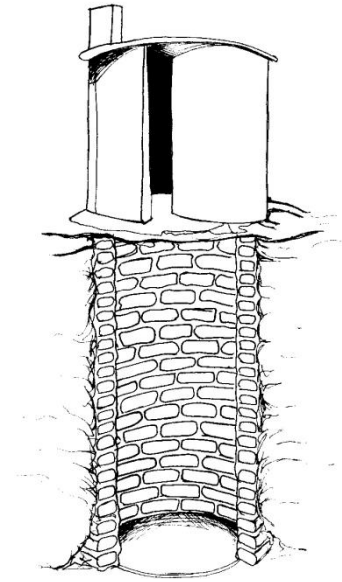
Figure 4. Comparison of Privies with and without Vent

Source: USAID

- WHAT IS IT?
- Simplest method of sanitation.
- An on-site disposal system without any effluent-Only seepage
- Used in villages and peri-urban areas

Conventional Pit Latrines: Construction and Operation aspects

- Consists of a pit in the ground with some superstructure for privacy.
- Hole can be lined (unstable soils)
- At least, the bottom should not be lined to allow for seepage
- Should normally be constructed in areas where:
  - The geology is not rocky
  - Groundwater table is not high
  - Water sources are not in the immediate vicinity (>15 to 30m down hill of a water source????)



Conventional Pit Latrines: Construction and Operation aspects

- Will have a superstructure for privacy

- Should have a squatting slab or pedestal

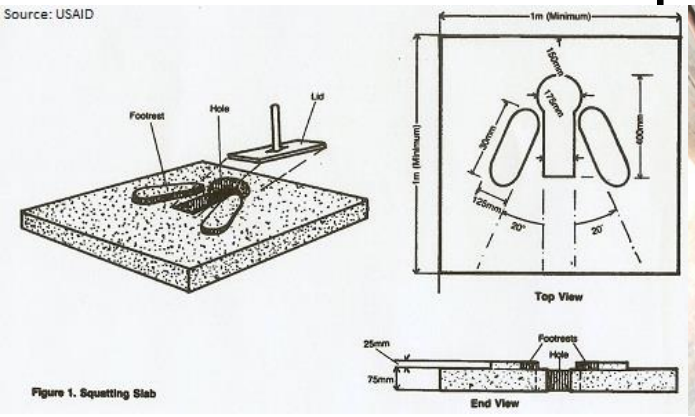
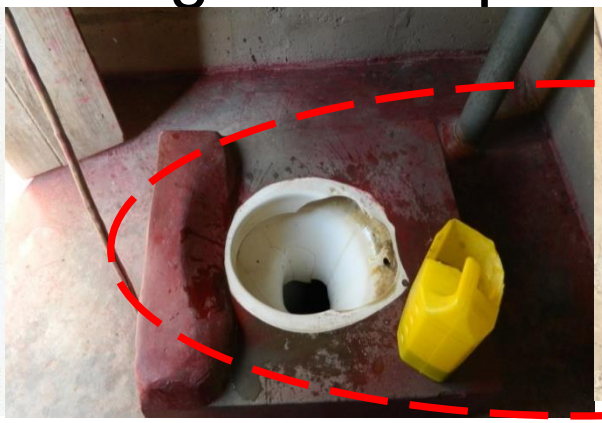
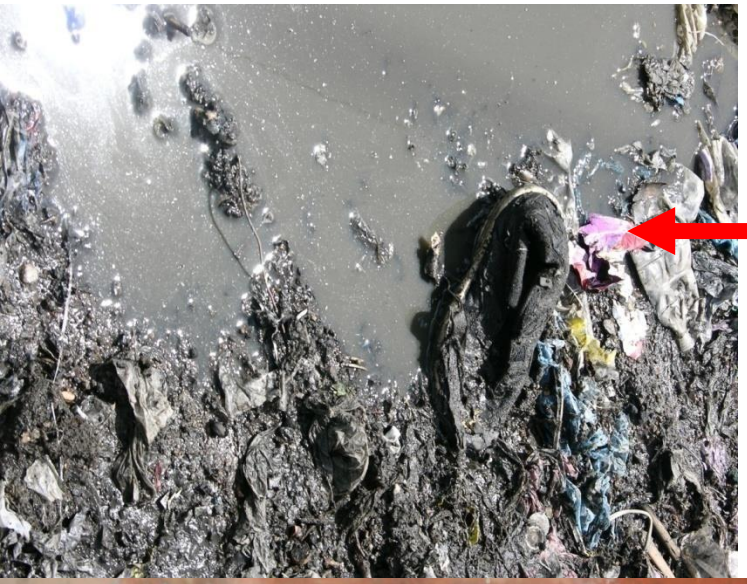


Figure 1. Squatting Slab



Hazard Isolated?

Problems With Conventional Pit Latrines



- Odour, flies
- Overflowing pits, no space to dig new pits
- Pit latrines have to be outdoors (safety issues)
- No means of emptying pits
- Groundwater contamination

Pit Latrine Operational aspects

- When about 2/3 to 3/4 full, it should be decommissioned.

- Should be filled with earth and replaced by a new pit (where land is adequate). Otherwise it should be emptied – Refer to FSM Section

- The opening should be kept covered when the facility is not in use (Awareness required).

Pit Latrine Operational aspects

- Designing of a latrine:
  - Estimate SAR (40 to 60 litres/cap.y)
  - Decide period required before replacement or emptying
  - Demographic data
  - Then volume can be computed (Take cognisance of the fact that pit latrines are also receptors of solid waste in most cases

THE VENTILATED IMPROVED PIT LATRINE

- Has special features to reduce odour and flies

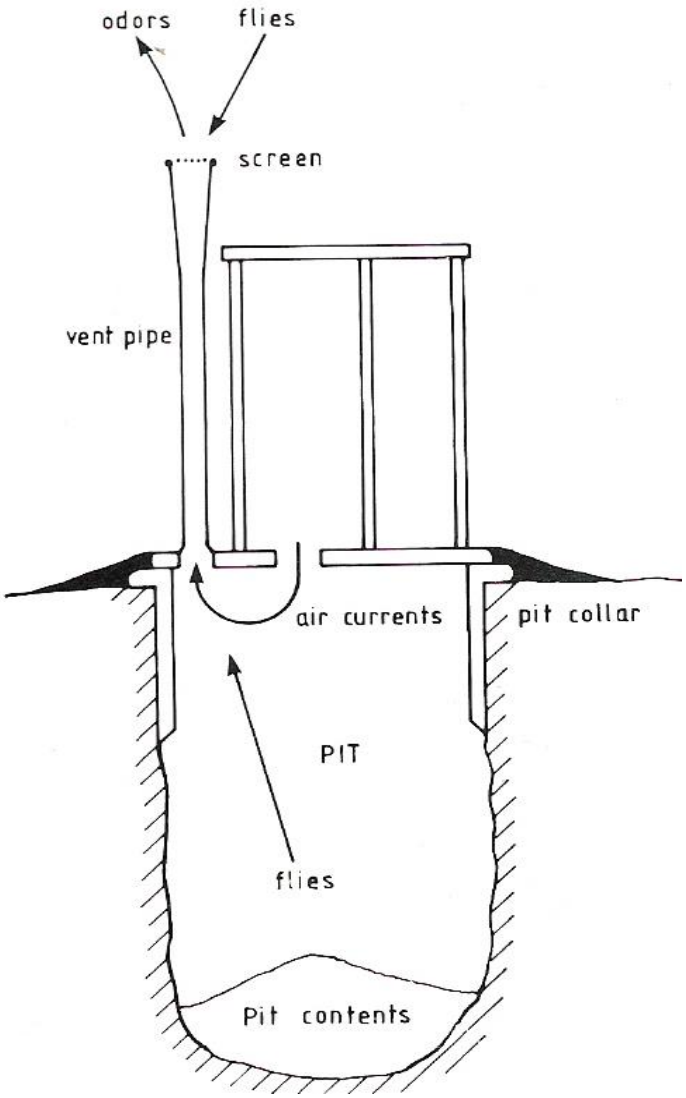
ODOUR REDUCTION

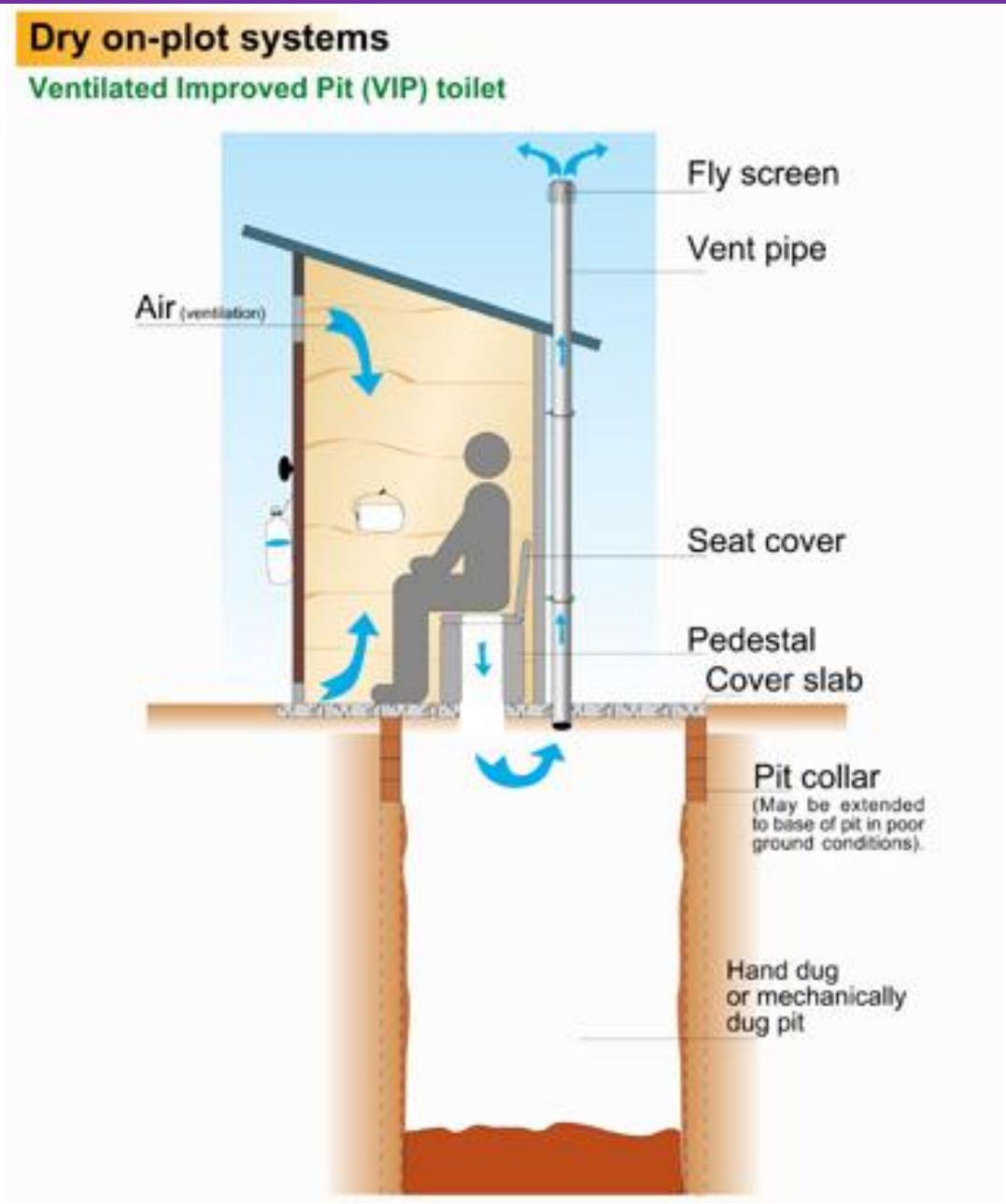
- Vent pipe (Maximum exposure to sun) and above roof level for air movement
- Colour of vent pipe should be black
- Vented door
- No closing of squatting hole

FLY REDUCTION

- Painting of the inside of toilet-Black
- Screen on vent pipe

THE VENTILATED IMPROVED PIT LATRINE





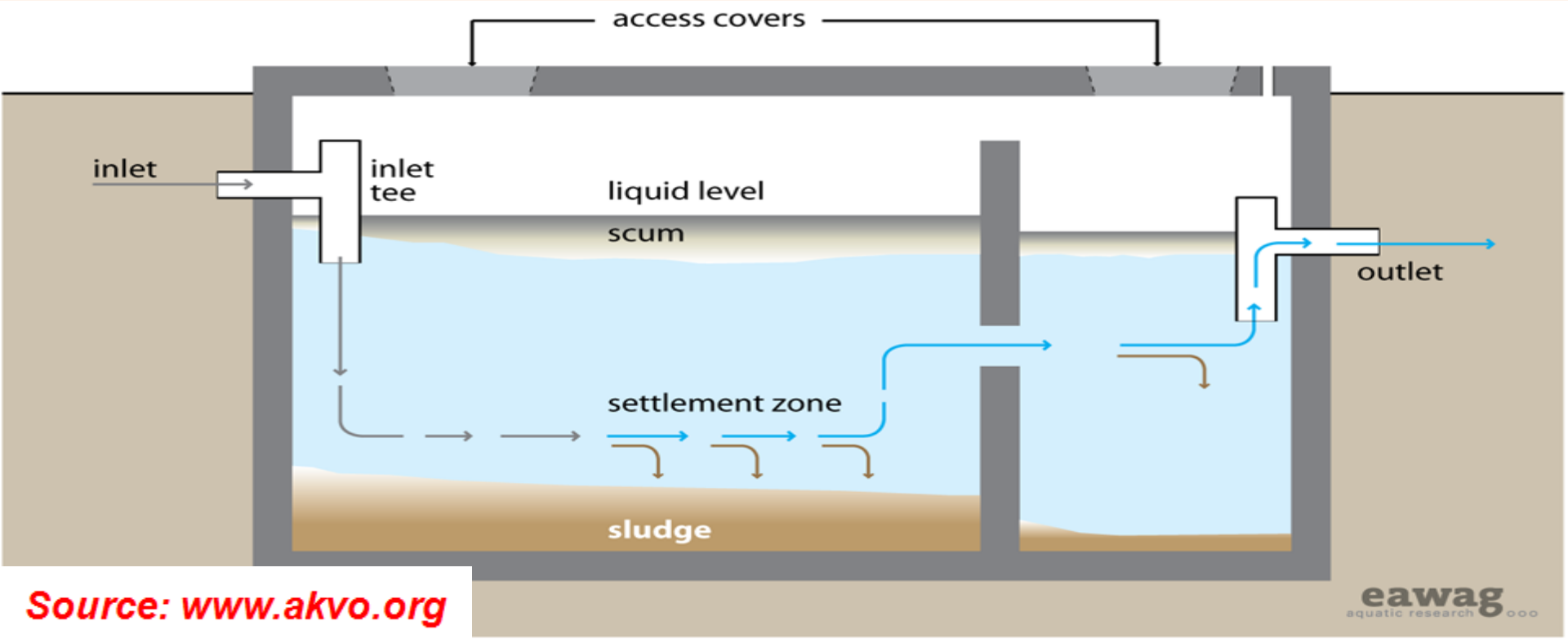
SOURCE: GOOGLE IMAGES

VIP Operational aspects (As for pit latrines)

- When there is no intention to use the accumulated faecal sludge, it should be buried when about 2/3 to 3/4 full.
- Should be filled with earth and replaced by a new pit.
- Should be sited about 30m from water sources like wells
- Where it has to be emptied Refer to FSM Section

Septic Tank: What Is It?

- A water tight settling tank in which wastes, usually from individual households, are flushed down a short sewer.
- Suitable for areas with adequate water supply but no sewerage system



Source: www.akvo.org

Septic Tank: Sitting

- To be used in areas with low ground water table and where the geological formation is not porous (Because the effluent from the tank goes to a soakaway for infiltration into the ground
- To be positioned at least 3m from water pipes
- Suitable in low density areas
- Should be located away from water sources (>30m from water wells; 7m from rivers, 3m from water pipes)……check Water Resourses SI (50m)

Septic Tank: Design and Operations

- Designed with a retention time of about 3 days which should not go below 1 day
- Water depth about 1-2m
- Should have at least two compartments in the ratio 2:1
- Inlet pipe (Tee) discharges downwards to avoid short circuiting (And to prevent scum going out)
- Partition wall perforated or open jointed a depth below water surface (This prevents scum from floating into second chamber)
- Discharge pipe is Tee to avoid scum floating to soakaway or drainfields (Avoid clogging)

Septic Tank: Design and Operations

- Usually, desludged once in 3 – 5 years (Need to know the average Sludge Accumulation Rate (SAR: 40 to 60 L/C.Year))

Septic Tank: Treatment Mechanism

- Treats solids anaerobically
- Liquid discharged into the ground via soakaway or drainfields where it gets treated through the process of filtration and other biological processes.

Septic Tank: Design and Operations

QUESTION:

Design a septic tank for a family of 20 people in Meanwood Ibex hill

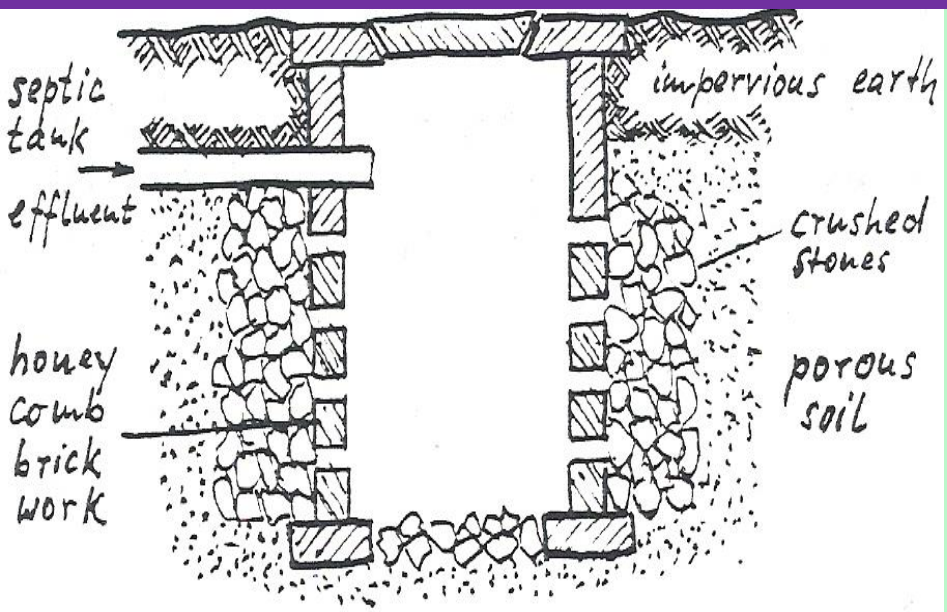
SOLUTION

- Compute hydraulic loading
- Choose retention time

WHEN TO DESLUDGE

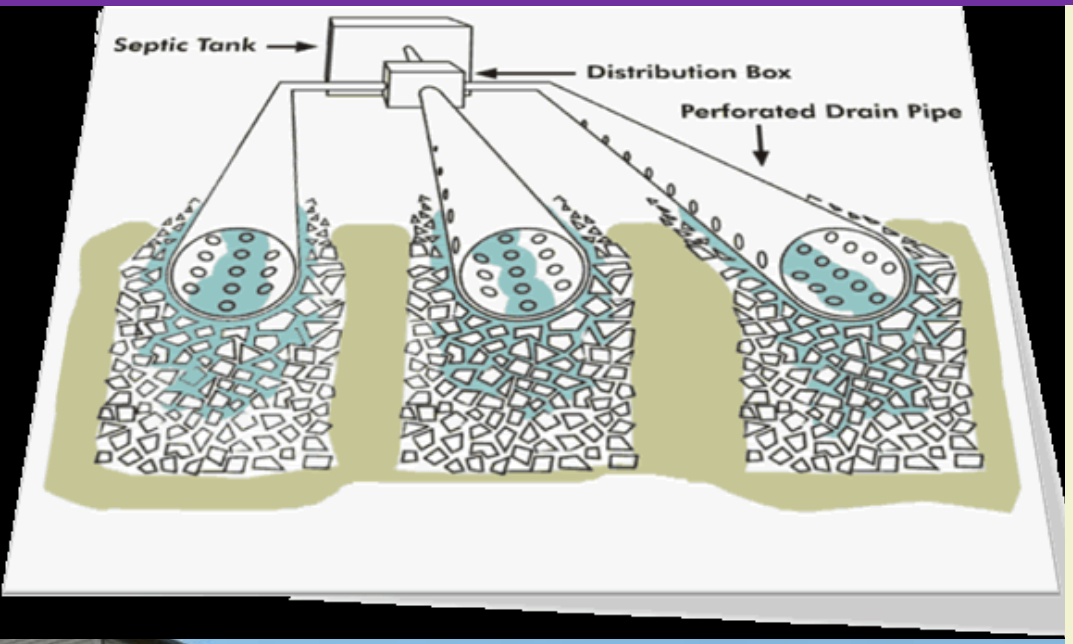
- SAR = 40 to 60 liters/c.year
- Decide minimum hydraulic retention time at time of desludging – Usually one day

Soakaway



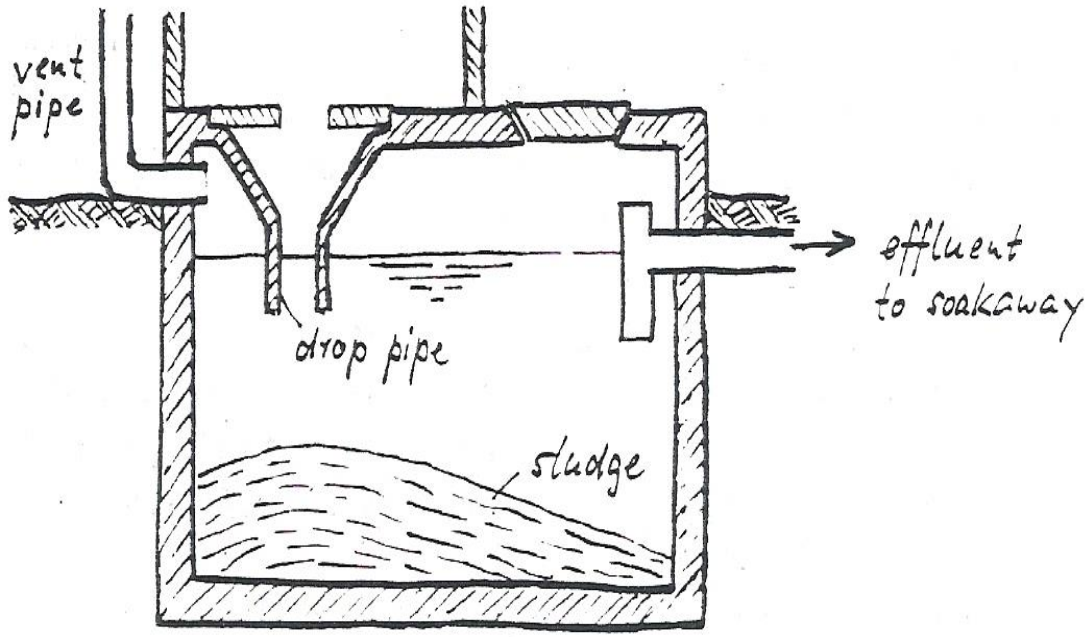
- Purpose is to aid infiltration of wastewater into the natural ground
- Consists of a circular or square walled-up hole in the ground
- Top 0.3-0.5m should be water-tight
- Lower part should be an open-jointed wall.
- Performance is dependant on soil characteristics and efficiency of the Septic Tank (Percolation test result: 15 to 100 seconds/mm drop)

Drain fields



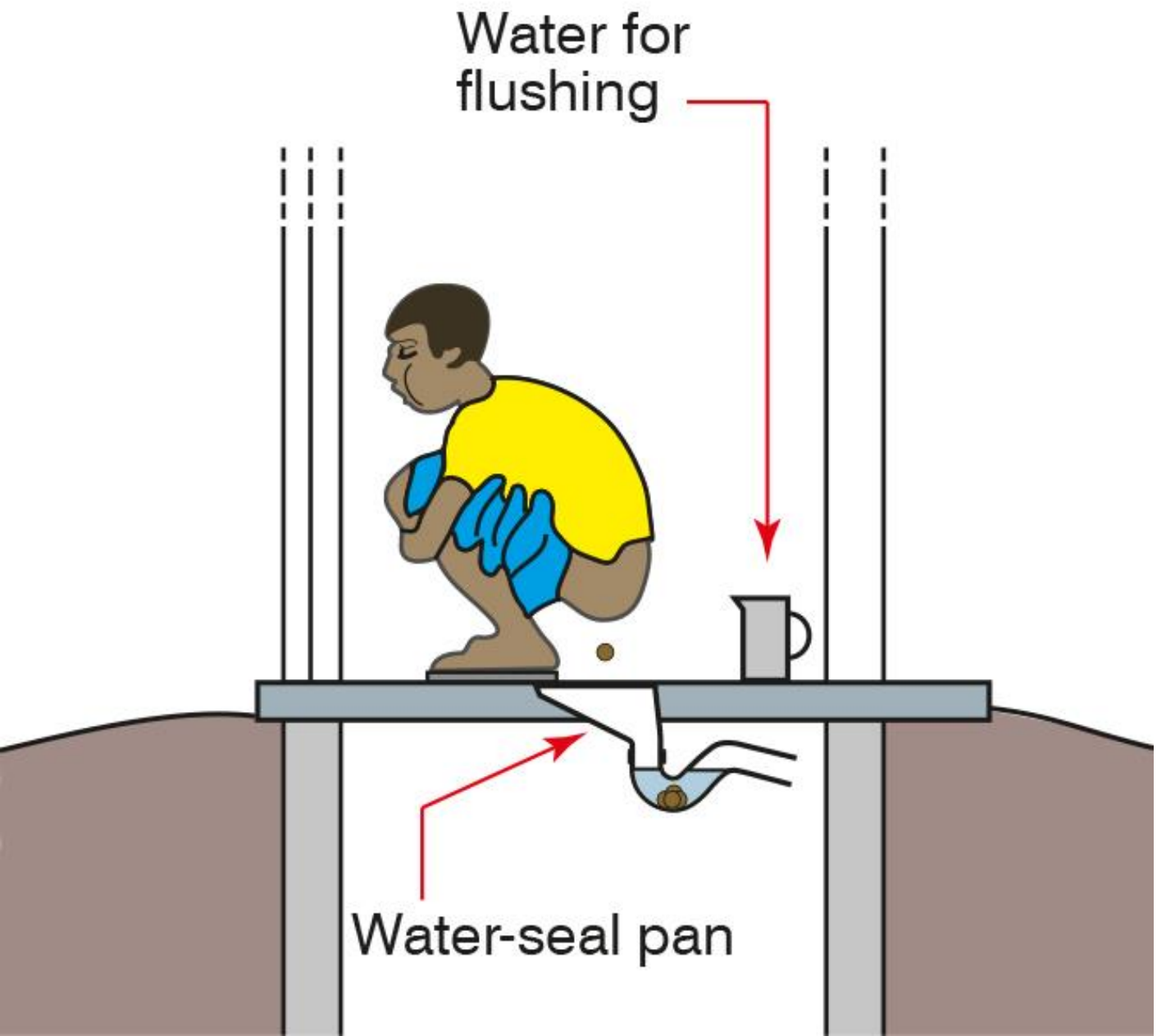
- Consists of trenches in series and parallel arrangement
- Each trench consists of an open jointed pipe
- Pipes are laid on rock fill or gravel fill then covered with earth
- Used where quantity of water to be infiltrated is huge (E.g. block of flats)

AQUA-PRIVIES (Pour Flush)



- A modified septic tank- 1-2 m^3
- Filled with water and directly below squatting pan.
- consists of a watertight concrete tank
- comparatively lower water requirements as compared to the septic tanks.
- Suited to areas without adequate water supply in the house

AQUA-PRIVIES (Pour Flush)



CESSPOOLS/CESSPIT

- A covered chamber with no overflow receiving and storing all the wastewaters from a dwelling or dwellings.

- Frequency of emptying is high and as such, this system has high operating costs.

Cartage or Conservancy or Bucket Latrines

- One of the oldest systems for excreta collection
- A bucket receives the excreta, (nightsoil).
- Bucket usually placed in bucket chamber directly under a squatting slab and is accessible through a back door from the street.

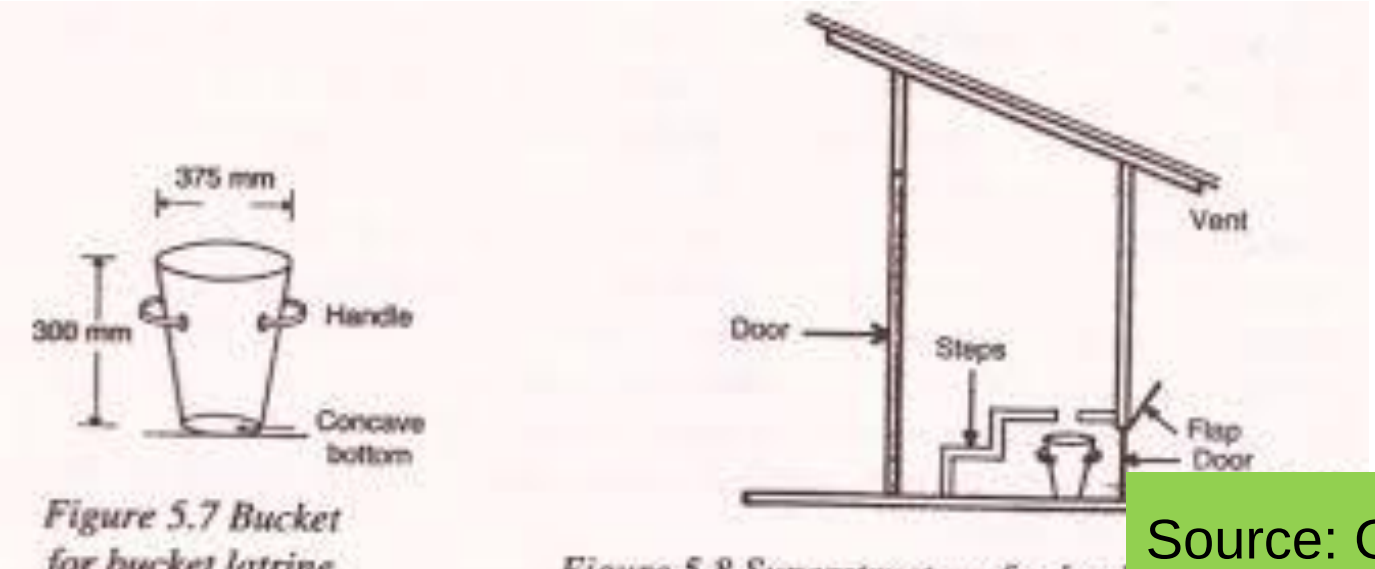


Figure 5.7 Bucket for bucket latrine

Figure 5.8 Superstructure for buck

bucket.

Source: Google Images

Bucket Latrines: Operational Challenges

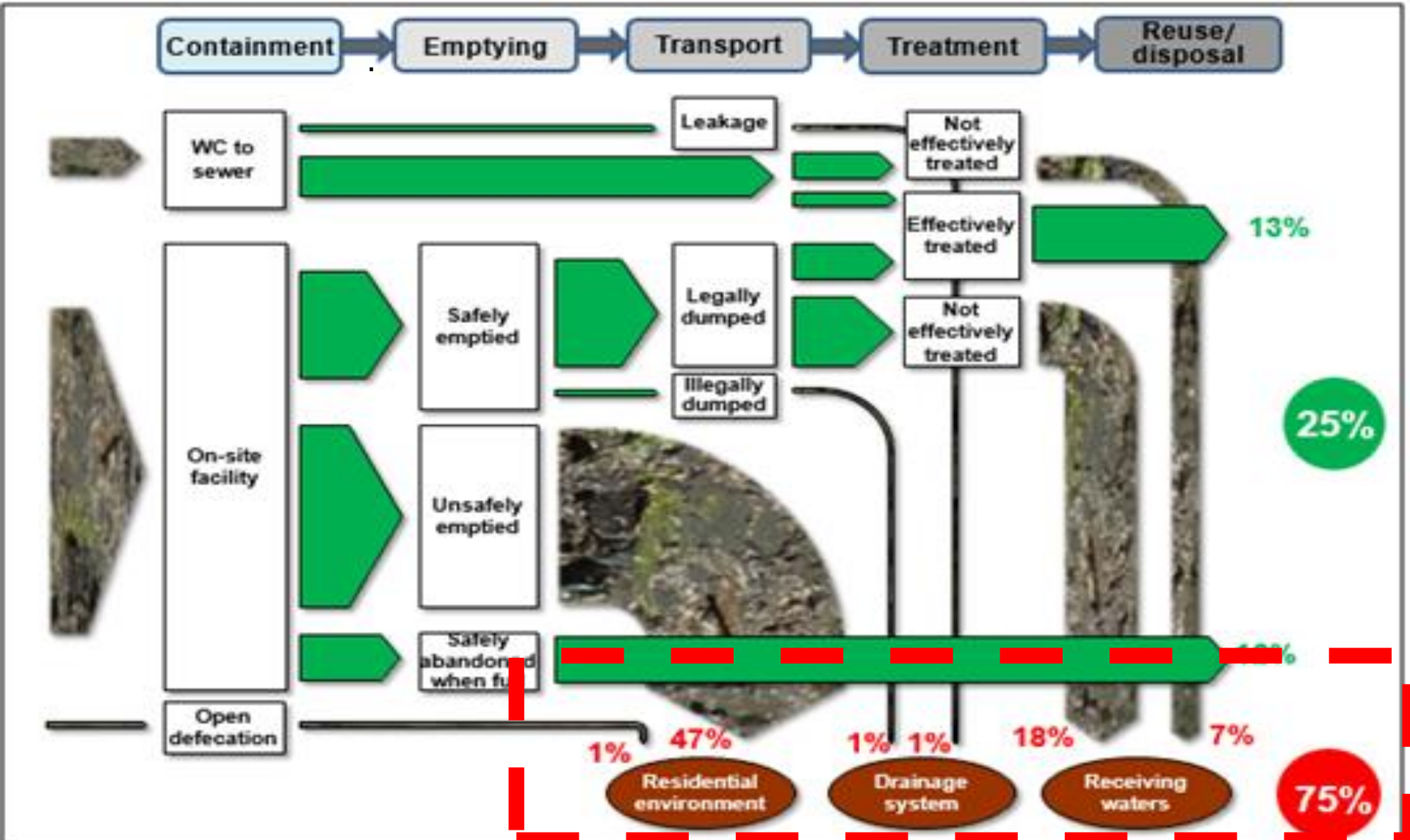
- Very difficult to operate in a hygienic way.
- Flies are a problem.
- Spillage occurs easily when the latrine is used and when the bucket is removed, emptied and replaced.
- Transport and disposal of the excreta may be connected with health hazards.

Faecal Sludge Management

- FSM is the storage, collection, transportation, treatment and safe enduse/disposal of Faecal Sludge (See sanitation service chain below)
- New field that has evolved due to the realisation that OSS are not complete without a functional FSM.
  - Faecal Sludge: Excreta which comes from onsite facilities and has not been transported through a sewer (Strande et. al., 2014)

Faecal Sludge Management

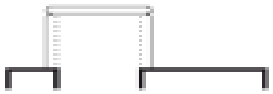
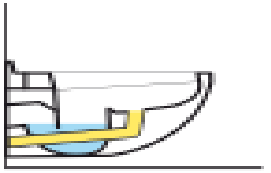
How to design intervention measures-Th e Shit Flow Diagram (SFD)



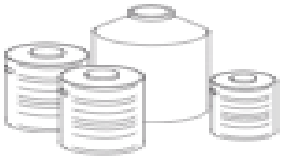
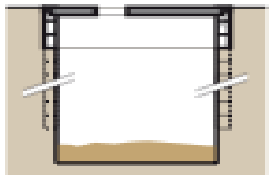
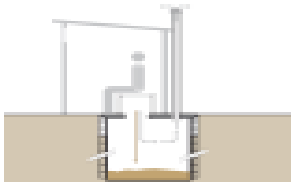
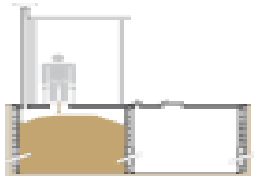
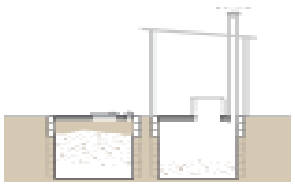
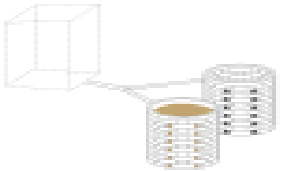
FSM: Captute and Storage or Containment

- Capture is by interface
- Needs to be user friendly

U - User Interface

 Dry Toilet	 Urine-Diverting Dry Toilet (UDDT)	 Urinal	 Pour Flush Toilet	 Cistern Flush Toilet	 Urine-Diverting Flush Toilet (UDFT)

S - Collection and Storage / Treatment

 Urine Storage Tank / Container	 Single Pit	 Single Ventilated Improved Pit (VIP)	 Double Ventilated Improved Pit (VIP)	 Fossa Alterna	 Twin Pits for Pour Flush

Interface: Considerations

- Need to be user friendly

- Need to respond to end-use requirements

Source: Google Images

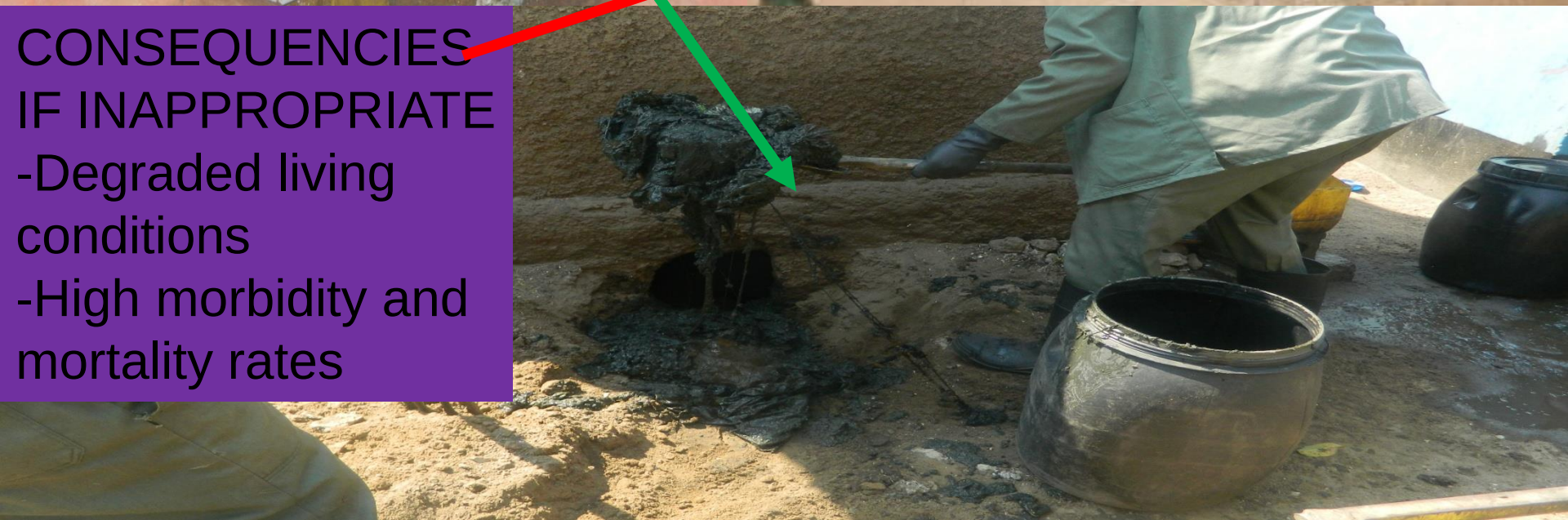
FSM Challenges

WHEN LATRINE GETS FULL – WHAT NEXT

CONSEQUENCIES IF INAPPROPRIATE

-Degraded living conditions

-High morbidity and mortality rates



FSM: Emptying and Transportation

Manual

Mechanical

Manual-Modified Garden Tools

Manually operated mechanical System (Gulper; Diaphram; Mappet etch)

FSM: Transportation

Mechanical

Push Carts

Emptying and Transportation: Considerations

- Accessibility of sites (Where inaccessible, then manual means are appropriate)
- Quality of faecal sludge (Solid waste content, rheological properties)

FSM: Treatment

- Faecal sludge will be highly concentrated
- Mostly anaerobic treatment systems are employed (Suitable for strong sludge)
- Drying beds (Unplanted and Planted)
- Co-treatment at conventional plants (Need to take care not to over load)

FSM: Reuse and Disposal/Resource Oriented Sanitation – The Omni Processor

Products from an Omni Processor

- Characteristics of an Omni Processor Plant
  - Treats up to 16.8t/day sludge with MC =0.4g/g dry sludge
  - Produces up to 3.6MW of electricity in 24 hours
  - Produces 26.4m^3 of water/day (demineralised)
  - Produces 9.6m^3 of ash in 24 hours

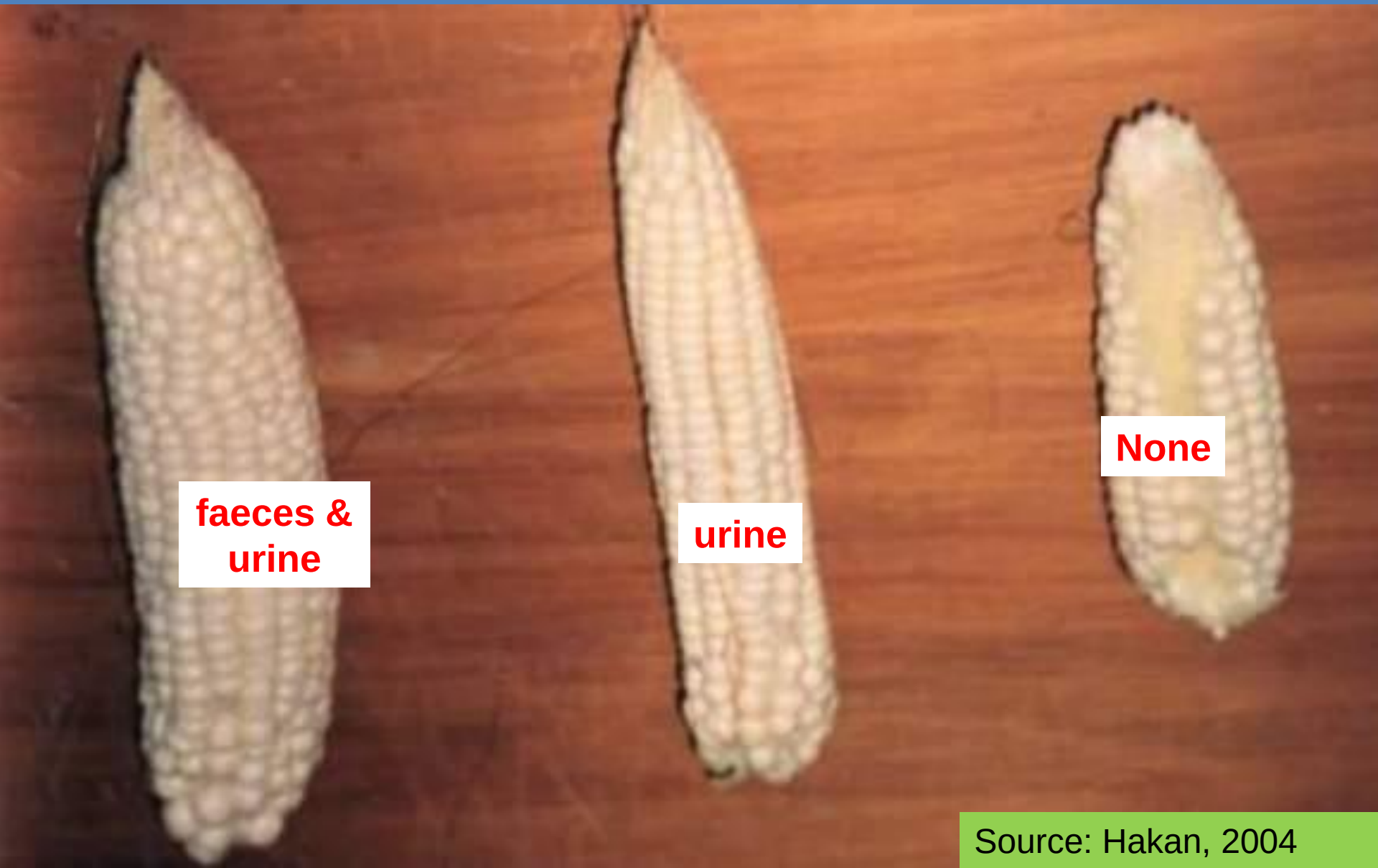
FSM: Reuse and Disposal/Resource Oriented Sanitation

FS Briquettes

FS Fertiliser

Black Soldier Flies

Reuse Of Faecal Sludge/Excreta Products Comparative Results



Source: Hakan, 2004

Pictorial Evidence: Rwanda

(Source: Håkan, 2004)

The fertigative effects of urine

Plant, growth period and number of repetitions n	Unfertilized plants g	Fertilized, 3:1 water/urine application 3x per week g	Relative yield fertilized to unfertilized
Lettuce, 30 days (n = 3)	230	500	2.2
Lettuce, 33 days (n = 3)	120	345	2.9
Spinach, 30 days (n = 3)	52	350	6.7
Covo, 8 weeks (n = 3)	135	545	4.0
Tomato, 4 months (n = 9)	1680	6084	3.6

(grams fresh weight) in plant trials with urine as a fertiliser to vegetables in Zimbabwe (Morgan, 2003)

Fertigative effects of excreta compost

Plant, soil type and number of repetitions	Growth period	Fresh weight topsoil only g	Fresh weight 50/50 topsoil/ FA*soil g	Relative yield fertilized to unfertilized
Spinach, Epworth soil (n = 6)	30 days	72	546	7 .6
Covo, Epworth soil (n = 3)	30 days	20	161	8 .1
Covo 2, Epworth soil (n = 6)	30 days	81	357	4 .4
Lettuce, Epworth soil (n = 6)	30 days	122	912	7 .5
Onion, Ruwa soil (n = 9)	4 months	141	391	2 .8
Green pepper, Ruwa soil (n = 1)	4 months	19	89	4 .7
Tomato, Ruwa soil	3 months	73	735	10 .1

* *Fossa alterna* soil

Average yields (grams fresh weight) in plant trials comparing growing in poor topsoil only, with growing in a mixture consisting of 50% topsoil and 50% Fossa alterna compost (Morgan, 2003)

END

THANK YOU