BIOLOGICAL ADDITIVES TO ENHANCE SANITATION FACILITIES LIFESPAN IN REFUGEE CAMPS

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The Product - LICE

- The Consortium LICE contains selected natural microorganisms (10^{6} to 10^{12} CFUs) seeded in a mineral absorbent's internal cavity: Zeolite
- Consortium Lice SM consists of aero-anaerobic microorganisms selected for their ability to quickly digest the organic matter of septic tanks or latrines. These microorganisms are simple Saprophytes of Group 1 of the infectious agents' classification.
- The Zeolite protects the exogenous microorganisms (as a shell) from the endogenous microorganisms brought with the faecal organic matter, with which they are in competition.
- The Zeolite can absorb up to 40% compared with its initial volume without disturbing its internals cellular walls.
- The Zeolite thus works like a vacuum cleaner in constant mode and attracts pathogens and organic material to break down completely.
- When the Co/Lice is setup at the start-up of a latrine, the exogenous are in higher number, take the place of the endogenous and block the sludge accumulation.

LICE – Prior Product Testing

Ivory Coast

- LICE was used in Ivory Coast for a trial period of 3 months (Sept-Dec 2013), in partnership with the IC Red Cross & IFRC, to reduce the sludge volume in school latrines connected to a holding tank.
- Volume of excreta measured in the holding tank at the start of the project: 3 m3, (2m x 4.5m v 0.33 m excreta height in the pit), treated with 3.6 kg of bacterial additive.
- Volume of excreta measured after 12 days after the inoculation dose: 0.27 m3, (2 m x 4.5m x 0.03 m height of excreta in the pit).

After 12 days, the reduction of the sludge volume was already 90% + total loss of smell

After 2 years from the end of the piloting (as of 25 May 2015), the volume is still 0,27 m3 (1 cm sludge height) without any additional seeding + no smell

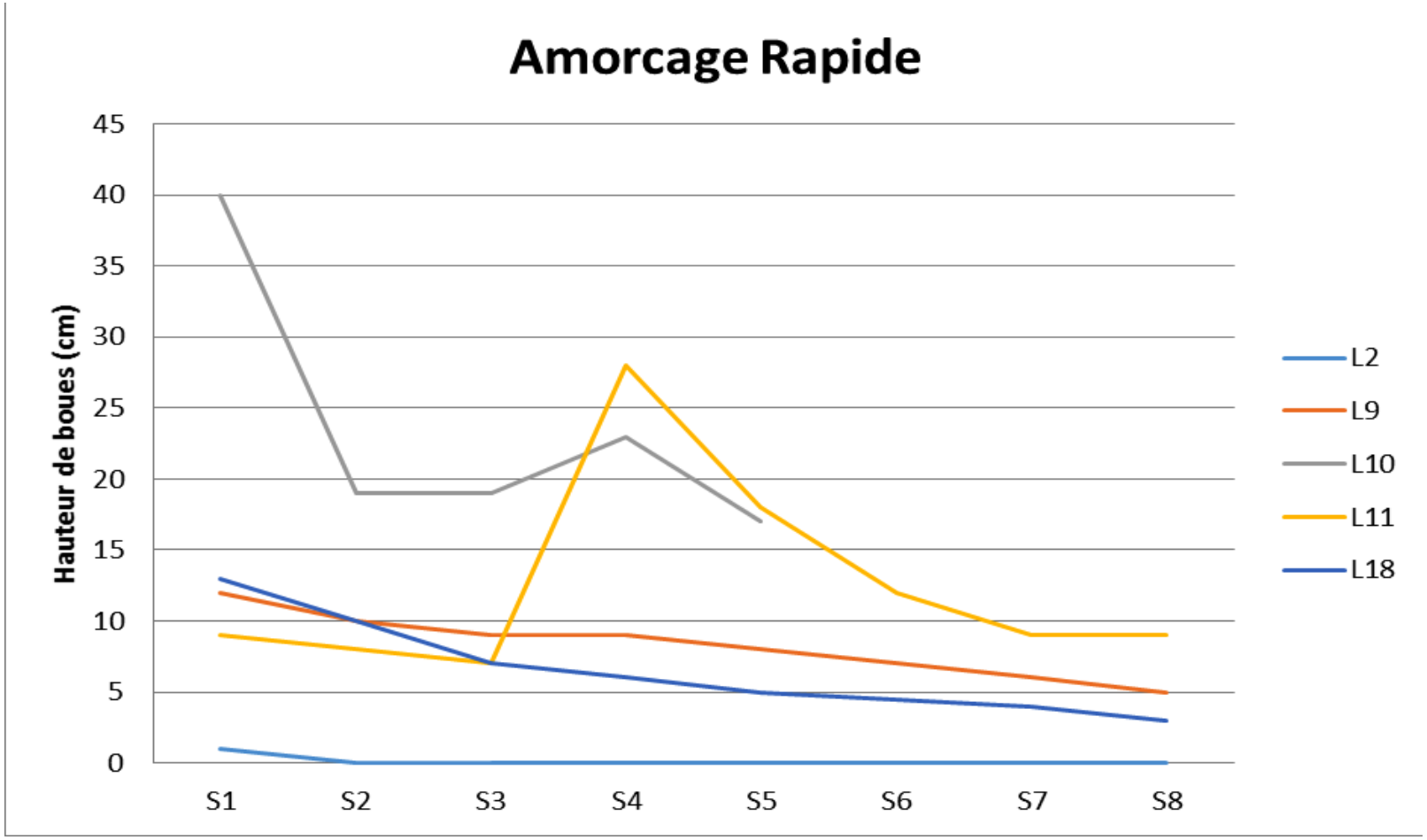
LICE –FIELD TRIAL CHAD

PHASE I - CHAD

- Context of the pilot: Southern Chad - Dosseye Refugee Camp
- Rational: 37% open defecation practice caused by poor maintenance and bad smell of latrines
- WASH Partner supporting with the monitoring phase: CARE
- Dates: 16 April – 4 June 2015 (50 days)
- Number of pit latrines tested: 5 in rapid priming, 5 slow priming, 10 blanks
- Results: 46% volume reduction & no smell
- Limitations: uncontrolled testing, wrong understanding of the protocol & non-regular number of users per latrine

LICE: UNHCR BIO-ADDITIVE FIELD TRIAL

PHASE I – Results (fast priming)



LICE: UNHCR BIO-ADDITIVE FIELD TRIAL

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PHASE II - CHAD

- Repeat with fixed number of users per latrines and respecting the protocol
- Dates: 31 August 2015 – 31 March 2016
- Number of pit latrines tested: 5 in rapid priming, 5 slow priming, 2 blanks
- Results:
  - 100% volume reduction in rapid priming latrines & no smell
  - 100% volume reduction in slow priming latrines & no smell
- Limitations: some latrines dried up (L1, L2 and L6) & needed additional water injection

LICE: UNHCR BIO-ADDITIVE FIELD TRIAL

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MONITORING PHASE- CHAD

- Stopped injection of LICE in March 2016 in the 10 latrines
- 7 months later, on Oct 29th 2016 the results showed:
  - In 3 out of 10 latrines the height of the excreta in the pit is stable (users diminished from 12 to 8)
  - In 2 out of 10 latrines, the **excreta level has increased** of 5-10 cm only (users halved)
  - In the remaining 5 latrines an **increase in the excreta level** was observed, which represents 1/3 of the level observed in the 2 blank / control latrines.

FIELD TRIAL LIMITATIONS

- Many uncontrolled variables:
  - Variable number of latrine users.
  - Changes in moisture content.
  - Incorrect/variable rates of LICE dosing.

- Means questionable results.
- Therefore need for a more scientific robust controlled field laboratory studies.

BIOLOGICAL ADDITIVE CONTROLLED FIELD LABORATORY TRIAL

- **The Objective** – to test the effect of biological additives on waste in pit latrines.

- Specifically:
  - Reduction in waste volume (to extend life of pit latrine)
  - Reduction in odor
  - Reduction in flies
  - Increased rate of sanitization (pathogen die-off)

BIO/CHEMICAL ADDITIVES RESEARCH

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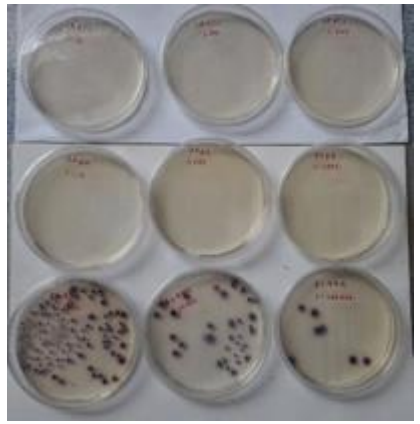
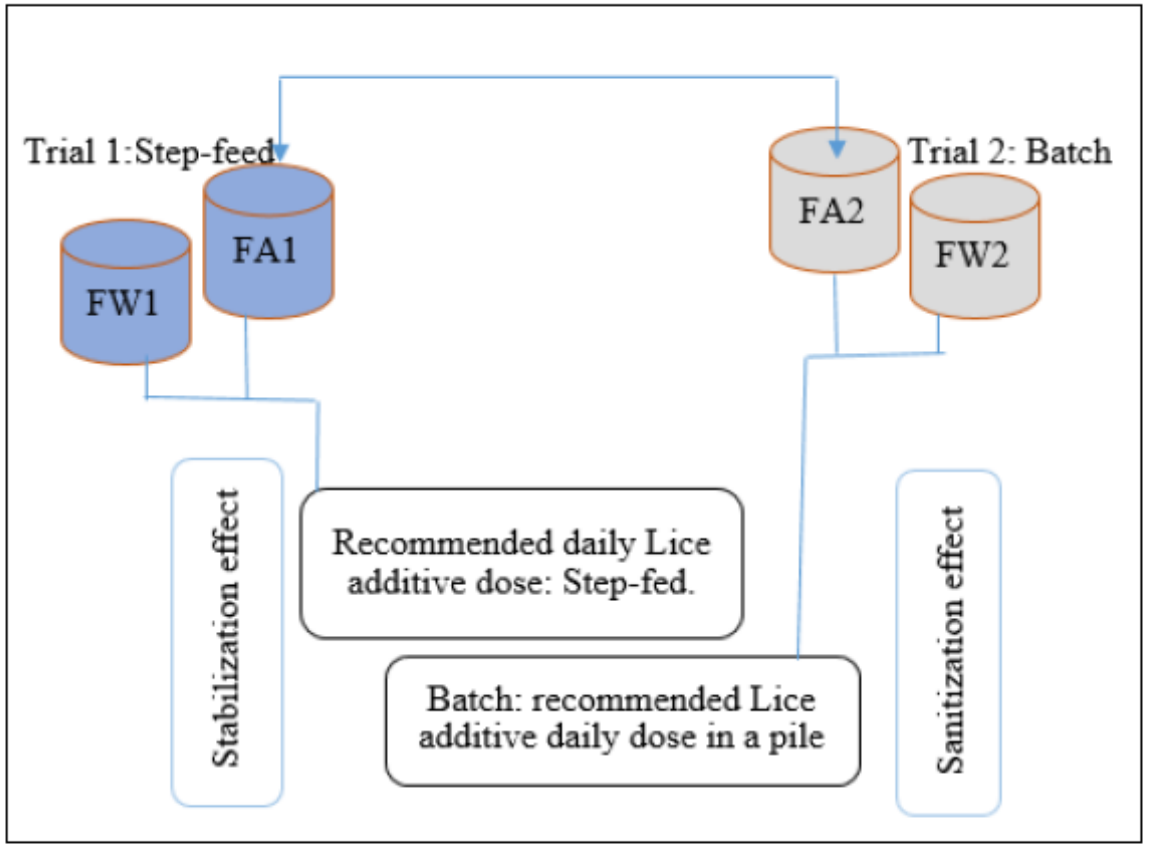
UNHCR PARTNERSHIP WITH UNESCO-IHE

- Combined laboratory scale field research - deployment of 2 students from UNESCO IHE (Kenya – Naivasha/Sanivation) in Dec 2015 and Jan 2016 using:
  - Chemical additives: Ikati and Soda
  - Biological additives: LICE, Sannitree, Ecotreat
- Objective: in 60 days - quantification of the reduction of volume and odor. Reduction in total volatile solids, COD, E. coli and fly attraction was also determined.



Methodology

- Fresh sludge from Sanivation toilets and Naivasha Prison.
- Controlled dosing in 20L plastic buckets (x3) to simulate pit latrines
- Mesurement of volume / weight
- Odour Test
- Fly Attraction Test
- Ecoli measurement



FA = Faecal sludge + additive FW= Faecal sludge and water only (Control)
All trials are in triplicates and in 5 sets in both T1 and T2.

Figure 3-5: Field Experiment: Schematic for Stabilization and Sanitization.

So summarising;

Trial 1: Step-feed –9 weeks quick priming – and daily dosing

Trial 2: Batch 1 – 8 weeks – dosed once but in layers of the recommended dose.

Odour

- Significant effect of LICE on odour reduction at 95% confidence level in both step and batch trials

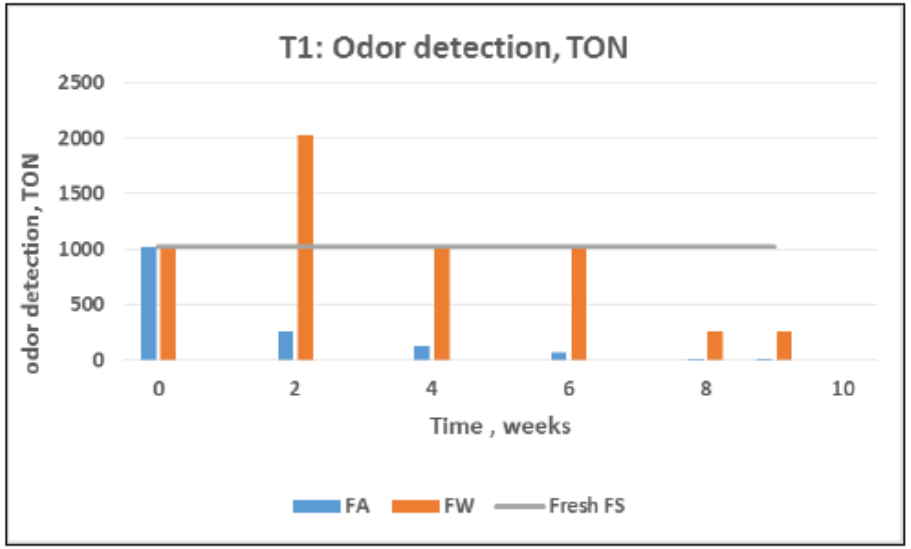


Figure 4-13: Odour detection in step- feeding trial

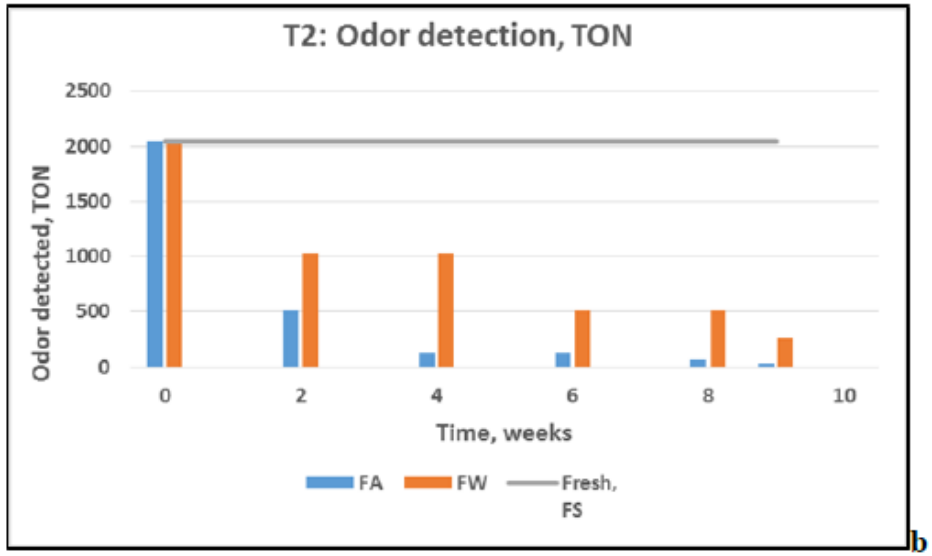


Figure 4-14: Odour detection in batch experiment

Fly Attraction

- Significant effect of LICE on odour reduction at 95% confidence level in both step and batch trials.
- Fly attraction is related to odour.

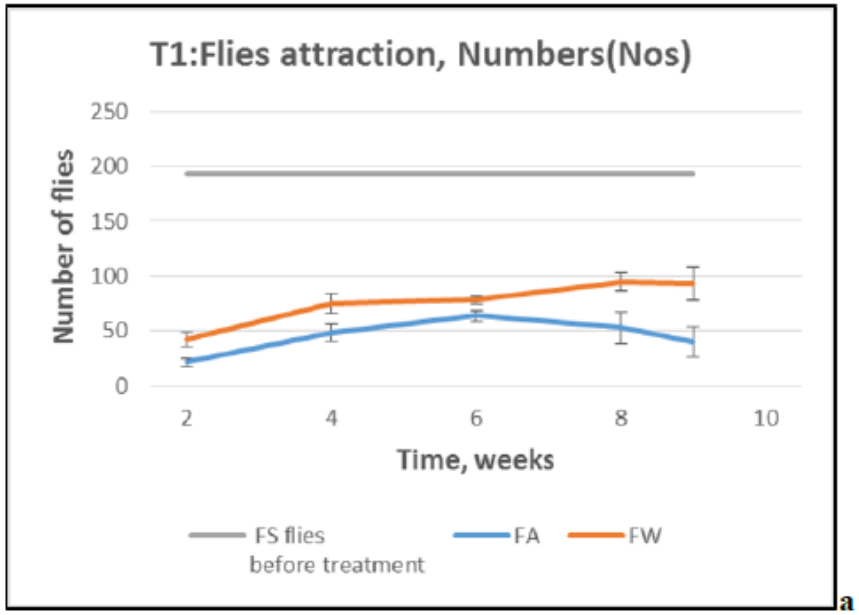


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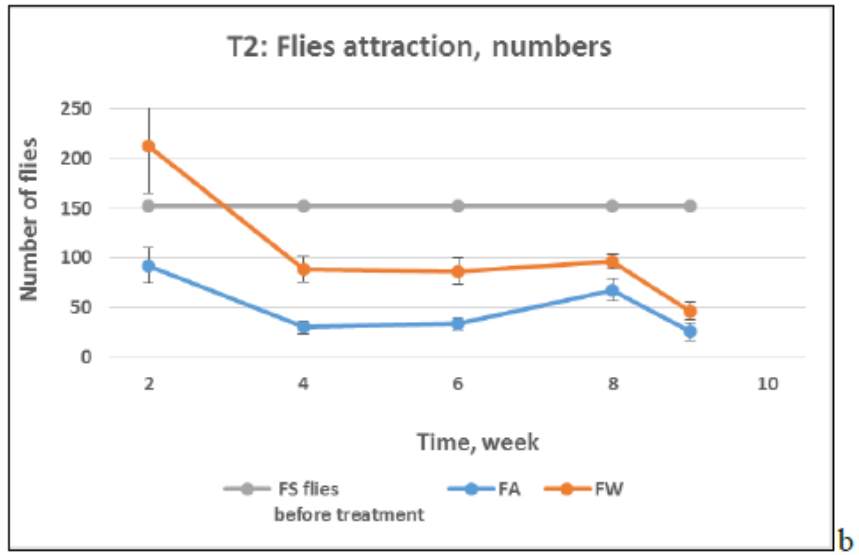
Figure 4-15: T1: Flies attraction, numbers.



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Volume

- No statistically significant ($p>0.05$) effect of LICE on reduction in sludge depth (volume) in both step and batch trials over 60 days.

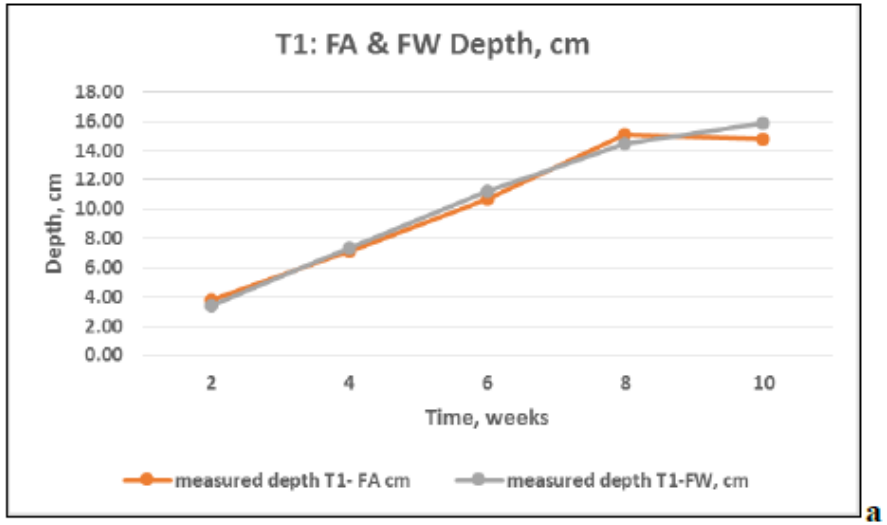

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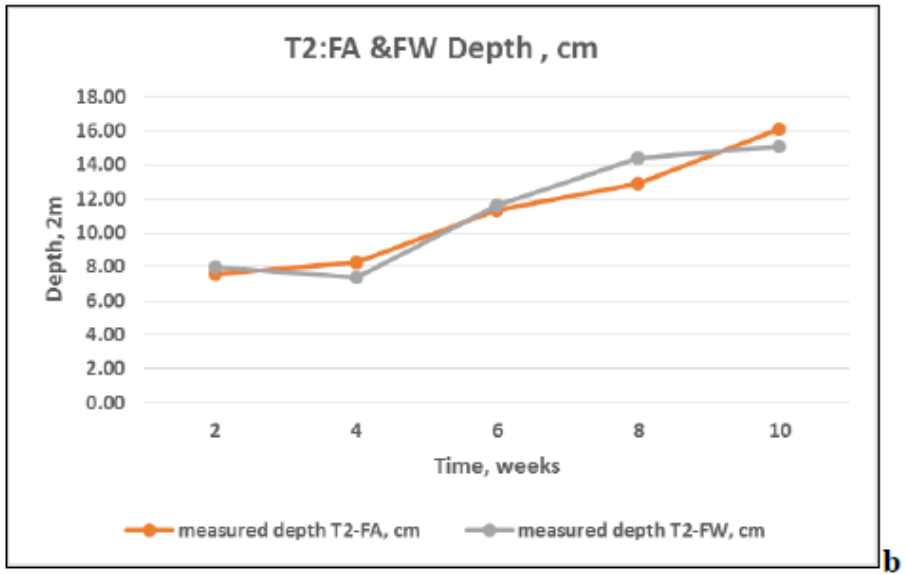
Figure 4-20: comparing measured depth, cm for FA & FW in T1.



b

Figure 4-21: comparing measured depth, cm for FA & FW in T2.

Mass

- No statistically significant effect (p>0.05) of LICE on reduction in sludge mass (weight) in both step and batch trials over 60 days.
- Weight reduction attributed to natural decay.

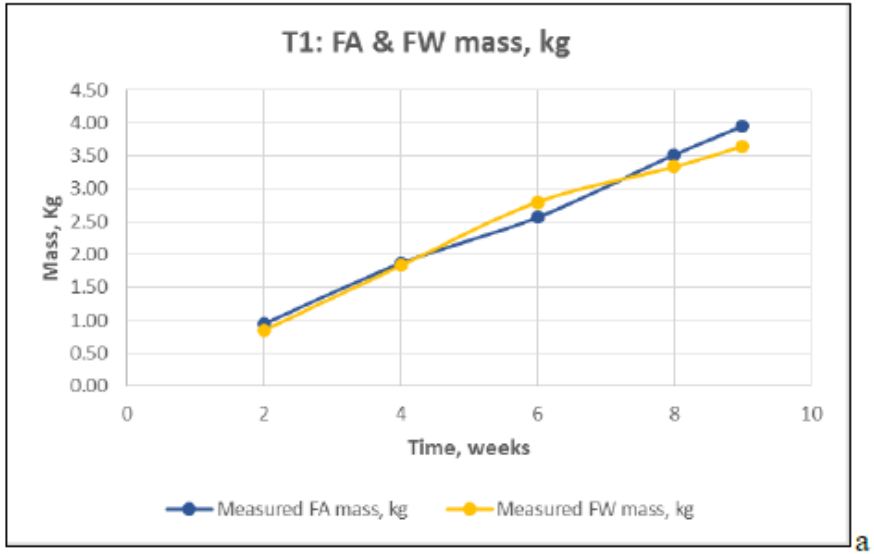


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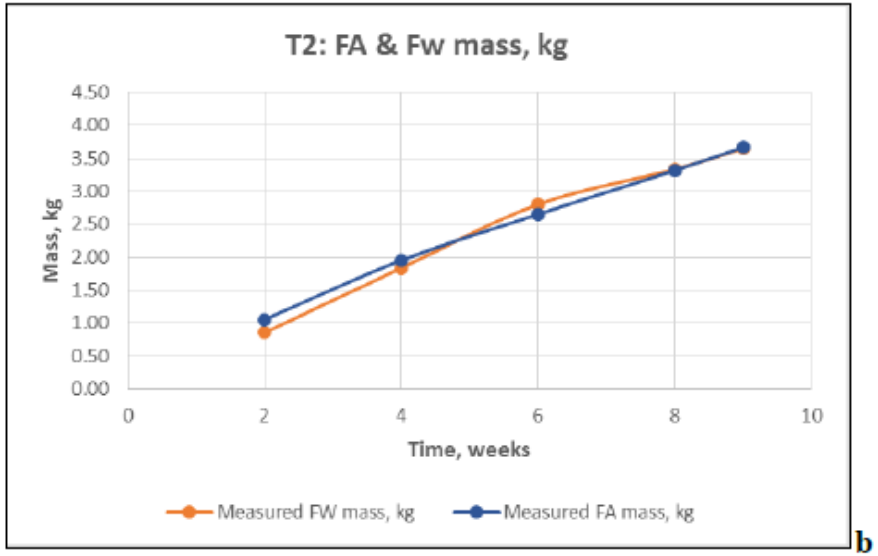
Figure 4-17: T1 (FA &FW) measured mass, kg



b

Ecoli

- No statistically significant effect (p>0.05) LICE on Ecoli (CFU) concentrations in both step and batch trials over 60 days.

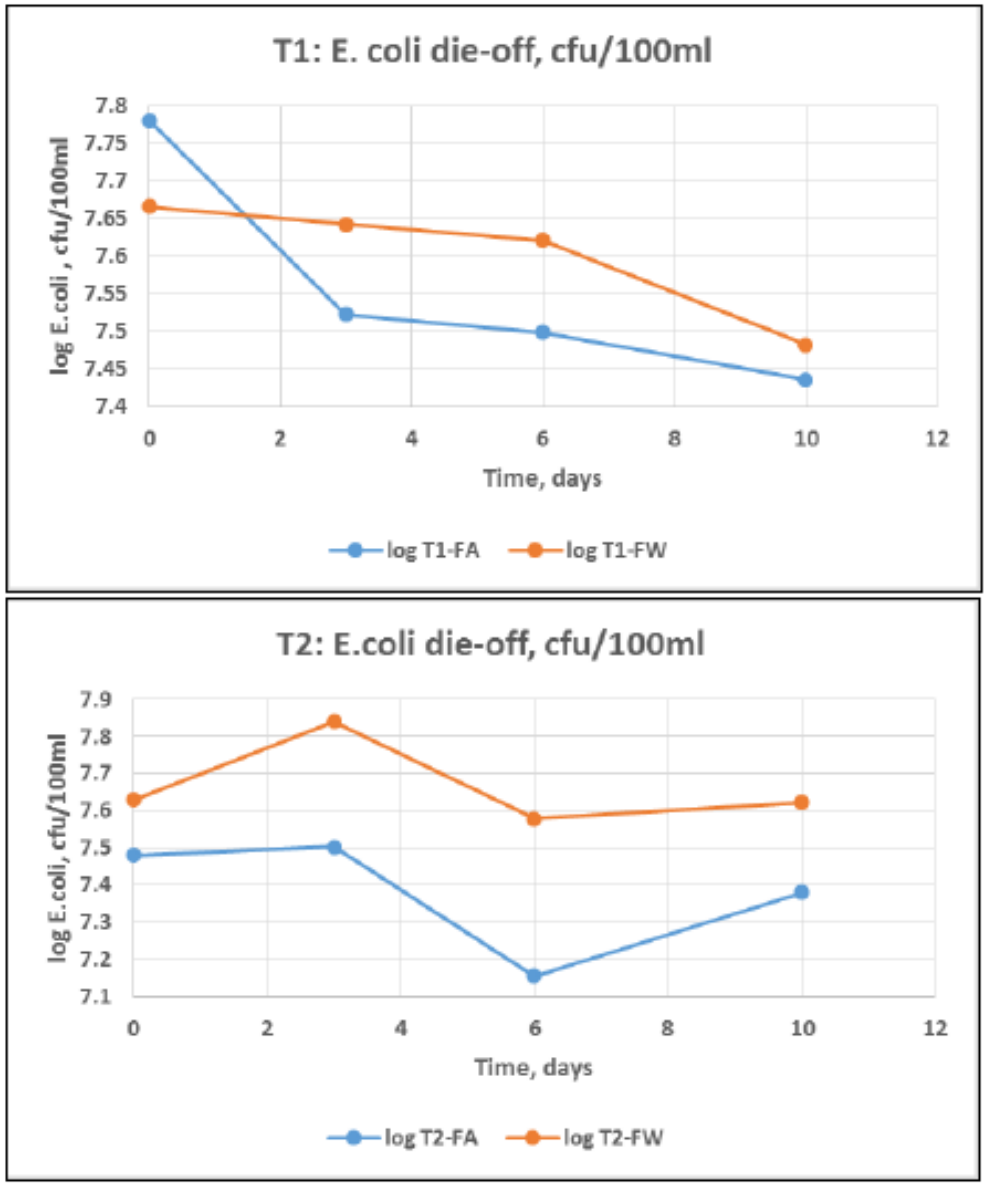


Figure 4-11: E. coli die-off in 10 days.

Cost

- Product Cost EUR620/m^3 of sludge treated
- With addition of labour and transport costs may be up to EUR EUR7,000/m^3

- RESULT: LICE achieved a 17% odour and fly attraction reduction.

Comparative Results (UNESCO)

- LICE (most expensive)
- Lime
- Ammonia
- Lactic Acid
- Ikati (best Ecoli reduction)
- Soda
- Ecotreat
- Ash

Comparison performance of additives										
Id	Attribute	Criteria	Lice	Lime	Ammonia	Lactic acid	Ikati	Soda	Ecotreat	Ash
References				(Nobela, 2015)	(Perez, 2015)	(Malambo,2015)	(Kemboi, 2015)		(Zindoga, 2016)	
1	**Sludge stability [%]**	VS/TS ≤0.6	**46.18±9 [T2]	[-]	[-]	[-]	35	40	66.8	58.4
2	**Sanitization**	**E.coli ≤ 3 log**	**5**	**< log 3**	**< log 3**	**< log 3**	**3**	**3.2**	**9.80E+07**	**1.67E +07**
3	**Sanitization time [days]**	t ≤ 30-60 days	N/A	2 hours	4 to 8 days	7 to 15 days	7	7	N/A	N/A
3	**Final pH value [-]**	4 ≤pH≥9.5	5.95±8	11-12.5	9-9.5	3.8-4.2	9	9.5	6	7.3
	Depth,		14.8±0.2	[-]	[-]	[-]	[-]	[-]	6.4	6.7
4	**Odor [TON]**	lowest TON achieved	16	[-]	[-]	[-]	[-]	[-]	1818	444
5	**Fly attraction reduction [numbers]**	lowest count	40±14	[-]	[-]	[-]	[-]	[-]	81/m2	5/m2
6	**Technology base**		Biological	chemical	Bio-chemical	Biological	chemical	chemcal	biological	
7	**Purchase price per kg, [€]**	**less than € 10**	**€28/kg [25-500kg] [€7.000/m^3 FS)**	**€12/m^3 [25kglime]**	**€16/m^3 (20kg urea)**	**€31.20/m^3 [100l milk] and € 2.20/m3 [100l molasses]**	**8.5/ m^3**	**13/m^3**	**€ 120.4/m^3**	**unknown**
9	**Robustness of technology**	Stability and sanitization ≤ 60 days	not attained	[-]	[-]	[-]	[-]	[-]	not attained	
10	**Shortfalls**		Protocol difficult to interpret and or daily use	Temperature dependnet	initial homogeneous mixing	initial homogeneous mixing	Bacteria regrowth	absorbs moisture	deployment restrictions	solids accumulation
11	**Disposal method**	Reusability	Agriculture	soil conditioner	Fertiliser	inoculum for subsequent treatments	unknown	unknown	Inoculum	Agriculture
12	**Suitability in emergency [score]**	highest compliance with criteria	4	9	8	6	10	8	1	N/A

RESEARCH RESULTS SUMMARY

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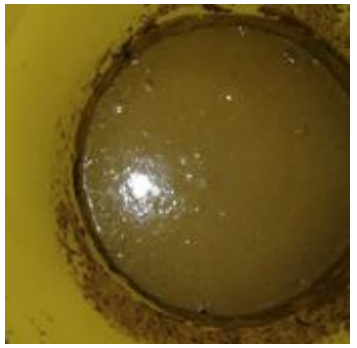
UNHCR PARTNERSHIP WITH UNESCO-IHE

- LICE could considerably reduce odour and flies (95%-100% reduction) in fresh faecal sludge, nevertheless, no stabilization or sanitization could be achieved, potentially due to the non-optimal ambient conditions (temperature below the optimal 37°C, which might have inhibited exogenous bacteria).
- Promising results on Ikati to accelerate sanitization of faecal sludge, though further optimization of the dosing is needed to prove impact.
- No evidence was found to support the claim that LICE (or the other Bio-Additives) can accelerate volume or mass reduction rate of fresh faecal sludge.



RESEARCH CONCLUSIONS

UNHCR PARTNERSHIP WITH UNESCO-IHE

- LICE has a potential for reduction of odour and fly attraction (disease vectors).
- Further evidence is required to determine the conditions where LICE may be effective at accelerating sludge volume reduction, and sludge sanitization.

ANY QUESTIONS?