



LEARNING BRIEF

Applying the WHO's multi-barrier approach to faecal sludge reuse

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Productive reuse of faecal sludge while safeguarding public health and the environment is important for meeting multiple Sustainable Development Goals. Application of the 'multiple barrier approach' can help achieve safe reuse without requiring costly faecal sludge treatment that may be unaffordable. This study demonstrates the need to continue to build sector capacity through practical application of the multi-barrier approach, and through such pilot studies, to understand and avoid common pitfalls and limitations of the approach.

In Nepal, as in several other developing countries, farmers sometimes fertilize their land using raw septic tank sludge or faecal sludge. SNV Netherlands Development Organisation (SNV) piloted the multi-barrier approach to facilitate safe reuse of faecal sludge, while testing a novel treatment barrier using fermentation by effective microorganisms. 'Effective micro-organisms' is a common additive in composting cow dung and crop wastes (green manure) in Nepal where it is believed to enhance the decomposition process and improve soil fertility.

This learning brief presents a summary of the experience applying the multi-barrier approach, drawn from the journal paper 'Faecal Sludge Reuse in Birendranagar, Nepal: A Case Study of the World Health Organisation's Multiple Barrier Approach' that reflected on two pilots conducted by SNV in Nepal. Both the learning brief and related journal paper were prepared by SNV and the Institute for Sustainable Futures at the University of Technology Sydney, as part of their partnership for research and learning to improve urban sanitation sector knowledge and practice.

Key messages

- **Pilot application of the multi-barrier approach for faecal sludge reuse can help build sector capacity in safe productive reuse.** The 'protected' space of a pilot allows testing, and even failing, that contributes invaluable experience and learning on low-cost approaches to re-use.
- **The treatment barrier (to reduce the pathogen hazard) must deliver a product that is adequately safe by WHO standards.** Multiple non-treatment barriers may not be able to limit risk of exposure adequately in the long term if the product has unsafe pathogen levels.
- **A systematic process is needed to design a multi-barrier approach that identifies all points of exposure to pathogens within the boundaries of the system.** The WHO's Sanitation Safety Planning Manual is a valuable source of guidance.

The multi-barrier approach, devised and advocated by the World Health Organisation, considers multiple strategies to eliminate or reduce public health risks to an acceptable level. It comprises of a series of control measures along exposure pathways and transmission routes to limit human contact with faecal pathogens. These include both treatment controls to reduce the pathogen hazard, and non-treatment controls which are a range of appropriate interventions to safeguard all people identified as at risk of exposure – sanitary workers, farmers, local communities and consumers.

Pilot aims

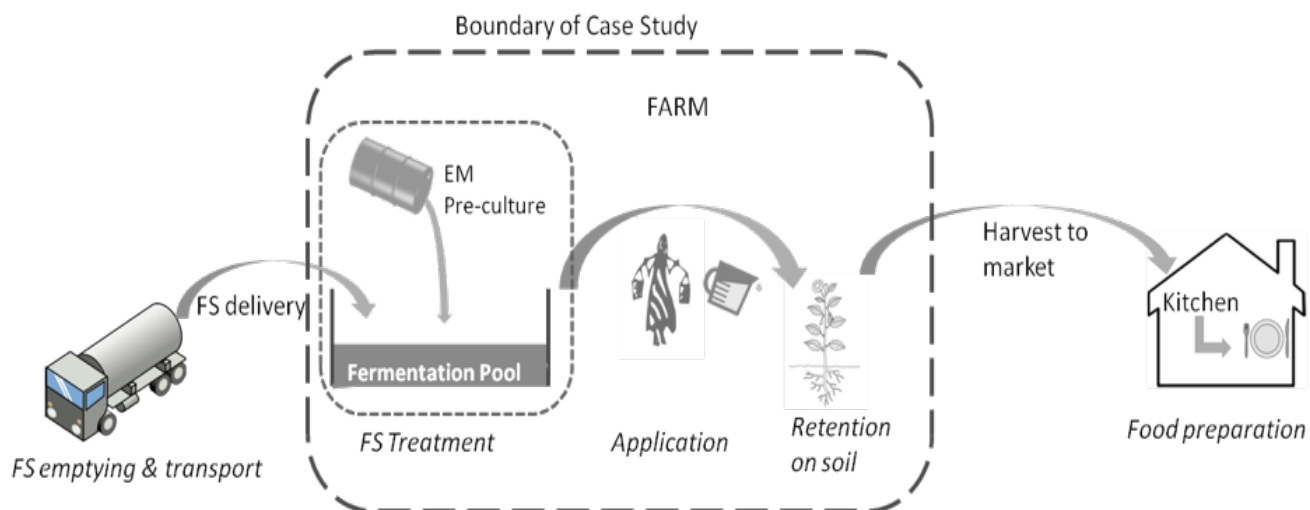
The study investigated the applicability of the multi-barrier approach in enabling safe and productive reuse of **faecal sludge** using a fermentation treatment process based on effective organisms. It addressed the questions:

- How safe is fermented faecal sludge for reuse, in terms of pathogen levels?
- How effective is the multi-barrier approach in reducing exposure to pathogens? What omissions and gaps occurred in the design, and how could they be addressed?

While this brief is focussed on the multi-barrier approach as above, the study also investigated how fermented faecal sludge performed in agricultural application, to determine whether efforts for improving safe faecal sludge reuse using this treatment process would be worthwhile. It found that the crop response to fermented faecal sludge (plant health, harvest quality and quantity) was at least as good as other common fertilizers it was compared with, and delivered higher profits per cultivated hectare by virtue of its lower cost.¹

Pilot set up

Two consecutive pilots were conducted – a preliminary investigation to identify key issues and inform a more targeted and improved investigation in the second pilot. They were implemented by farmers using a **Farmer Field School framework**, an established model for participatory experiential learning developed by the UN Food and Agriculture Organisation (FAO), where farmers can merge traditional knowledge with new information as it best suits their local contexts and needs.



Clip Art from Microsoft Office collections.

Figure 1. Schematic of the faecal sludge reuse pilots

1. Please refer to the learning brief for more details of the comparative study in agricultural application, and effective micro-organisms-based fermentation treatment for faecal sludge.

Implementation involved the following:

- Farmers were trained in conducting the faecal sludge treatment by effective micro-organisms fermentation, and in safe practices for applying the fertiliser to crops (use of personal protective equipment, safe application practices).
- Samples of the treated faecal sludge were sent for laboratory analysis for key indicator pathogens.
- Farmers ceased application of fertilizer a month before crops were harvested to allow pathogen die-off. Crop samples were sent for laboratory analysis for key indicator pathogens.
- Farmer perceptions were captured through surveys and qualitative methods.

What was learnt about the treatment barrier?

The laboratory results showed that effective micro-organisms-based fermentation treatment in the two pilots did not provide adequate reduction of the pathogen hazard with respect to helminths.

Although the results were not statistically significant due to shortcomings in sampling methods, the laboratory analysis provided important *indicative* information. They showed:

- *E. coli* levels (no higher than 10^5 (MPN index)/100 ml) that may represent adequate risk reduction when applied with adequate post-treatment multi-barriers. Further pathogen reductions are likely to take place with irrigation and exposure to sun and soil, and home rinsing in clean water.
- *Helminth* levels (ranging from 4000-100,000 eggs/litre) significantly exceeding safe limits for wastewater reuse, which should be < 1 helminth egg/L to adequately protect farmers and their families, and even lower if children are exposed.

The presence of helminth eggs pointed to the need for improvements to the treatment barrier. This could be achieved through another treatment stage before or after fermentation, including beginning with sludge that had been stored for a period sufficient for die off.

What was learnt about the non-treatment barriers?

The design of non-treatment barriers were focussed mainly on the process of 'application' (figure 1). Farmers were reported to have observed practices in accordance with their training when carrying and applying fermented faecal sludge to the test plots, including ceasing one month before harvest.

In the first pilot, farmers wore gum boots, gloves, face masks and aprons when handling fermented faecal sludge, however some slippage in the use of personal protective equipment was reported in the second pilot. While this was partly due to equipment being torn, it also demonstrated the challenge of maintaining behavioural controls over time.

The observed use of personal protective equipment suggested that regular reinforcement of safety and hygiene requirements is needed, including processes and budgets for inspection and replacement of protective gear.

The participatory experiential learning model led farmers to recognise that crops can be selected to act as a barrier. Whereas they chose ground-level produce in the first pilot (potatoes, cabbages and cauliflower) that are easily contaminated by fermented faecal sludge fertilizer, they chose crops with above-ground produce (peas and gourds), in addition to ground-level pumpkin in the second pilot. Helminth eggs were detected on the pumpkin sample analysed, while none were detected on bottle gourds and bitter gourds. Helminths were however detected on cow pea samples fertilised with fermented faecal sludge, but also on samples fed with traditional compost and chemical NPK mix – a surprising result suggesting other paths for helminth contamination apart from application of fermented faecal sludge fertilizer.

While crop selection and die-off periods can reduce risk of pathogen contamination, careful diagnostic analysis of crop contamination pathways including handling practices may be required to address contamination that has no obvious explanation.



The limited focus on application of fermented faecal sludge in the design of the multi-barrier approach left some gaps in identifying all possible exposure pathways within the system. With guidance from the WHO's Sanitation Safety Planning Manual, a systematic consideration of the potential flow of pathogens and points of exposure can help close the gaps, such as in table 1.

Multiple barriers and control measures should be designed by considering all potential exposure paths and transmission routes through a systematic process. Participation of local stakeholders can help identify local risks and develop appropriate locally owned control measures.

Microbial hazard	Hazardous events leading to exposure	Groups at risk of exposure	Possible control measures	Considered in pilots	
Pathogens in fermentation pool	Accidental falling into pool	Farmers, when	<ul style="list-style-type: none"> • Safety barriers • Appropriate tools with long handles 	No	
		<ul style="list-style-type: none"> • covering/uncovering plastic covers on fermentation pool • stirring mix daily during treatment phase • removing treated product in buckets 		Yes	
		Community and animals wandering into area		<ul style="list-style-type: none"> • Restricted access to area • Adequate fencing and warning signage 	No
Pathogens in treated fermented faecal sludge during application to crops	Accidental dermal contact with hazardous product	Farmers, when	Personal protective equipment <ul style="list-style-type: none"> • gloves • boots • aprons • face masks 	Yes	
		<ul style="list-style-type: none"> • lifting and carrying buckets filled with product • pouring product onto plants 		Yes	
		Consumers of produce		<ul style="list-style-type: none"> • Withholding time before harvest • Choice of crops with lower risk for produce contamination • Hygienic practices (e.g. hand washing before and after handling produce) 	Yes
Soil transmitted helminths on land fertilized with fermented faecal sludge	Contamination of crop produce	Farmers, community members walking in bare feet and/or handling soil on affected land	<ul style="list-style-type: none"> • Advice to local community to restrict access of children • Protective footwear • Gloves when performing tasks such as weeding 	No	
		Ascaris infection through ingestion of eggs from water that is contaminated by run off from fertilized land		<ul style="list-style-type: none"> • Protective footwear • Gloves when performing tasks such as weeding 	No
		Community members exposed to receiving waters from affected land		Run off management (e.g., appropriate barriers, holding ponds and filtration media to minimize helminth eggs in run off)	No

Table 1. Example of systematic consideration of pathogen exposure pathways within the pilots (refer to figure 1)

While transmission of helminth from inadequately treated faecal sludge can in theory be controlled by non-treatment barriers like those in table 1, these barriers could be difficult to maintain over the long term (e.g. footwear, restricted entry, run off management during extra heavy rains) while helminths can persist in the soil for months or years.

Non-treatment barriers should not be relied upon to manage the risks of inadequate faecal sludge treatment – the hygienic quality of treated faecal sludge must meet the WHO's standards for safe reuse.

The participating farmers were positive overall about using fermented faecal sludge and interested in using it again in the future. However they had reservations about whether the produce was safe for consumption, and expressed the desire for further research to determine safety. The surveys failed to monitor farmer attitudes specifically regarding the multi-barrier approach, e.g. use of PPE.

Monitoring farmer perceptions and concerns about the multi-barrier approach would enable future training to be better targeted.



Concluding reflections

Piloting the multi-barrier approach for safe reuse of fermented faecal sludge provided many useful lessons. Review and reflection on the pilots concluded that further research to ensure the safety of effective micro-organisms-based fermented faecal sludge fertilizer use is warranted, as it appeared to be an effective fertilizer that farmers reported as easy to prepare and use, that could potentially replace traditional fertilizers that are increasingly more difficult and costly to obtain. However, despite this promise, this pilot demonstrated that the resultant sludge was not safe according to WHO standards, requiring additional non-treatment barriers to be in place.

The pilots also demonstrated that the non-treatment barriers rely on consistent safe behaviour, however such behaviour may be challenging to institute and to sustain. This points to the importance of effective behaviour change communication approaches as well as monitoring of behaviours over the longer-term.

In addition to strengthening the treatment and non-treatment barriers as identified through the pilots, further research could support effective monitoring and support systems for maintaining controls and understanding long term impacts of fermented faecal sludge application, changes to agriculture practices and hygiene behaviours. Further investigation for building farmer and public confidence on safe faecal sludge reuse is also indicated.



About us

SNV Netherlands Development Organisation

SNV Netherlands Development Organisation (SNV) is a not-for-profit international development organisation with a long-term, local presence in over 30 countries in Asia, Africa and Latin America. SNV's global team of local and international advisors works with local partners to equip communities, businesses and organisations with the tools, knowledge and connections they need to increase their incomes and gain access to basic services – empowering them to break the cycle of poverty and guide their own development.

SNV's Urban Sanitation & Hygiene for Health and Development (USHHD) programme works with municipal governments to develop safe, sustainable city-wide services. The programme integrates insights in WASH governance, investment and finance, behavioural change communication and management of the sanitation service chain. We engage private sector, civil society organisations, users and local authorities to improve public health and development opportunities in their city.

As part of our USHHD programme, we have a long term partnership with the Institute for Sustainable Futures, University of Technology Sydney (ISF-UTS) focused on research and learning to improve practice and contribute to the WASH sector knowledge and evidence.

For further information please visit: www.snv.org

Institute for Sustainable Futures, University of Technology Sydney

The Institute for Sustainable Futures at the University of Technology Sydney (ISF-UTS) works with industry, government and the community to develop sustainable futures through research and consultancy. ISF seeks to adopt an inter-disciplinary approach to its work and engage partner organisations in a collaborative process emphasizing strategic decision-making.

For further information please visit: www.isf.uts.edu.au

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This learning brief draws on the following submitted journal paper:

Abey Suriya, K., Khawaja, N., Mills, F., Carrard, N., Kome, A., and Willetts, J., 'Faecal Sludge Reuse in Birendranagar, Nepal: A Case Study of the World Health Organisation's Multiple Barrier Approach'. *Water Practice and Technology* (under review).