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Technology options for faecal sludge management in developing countries: Benefits and revenue from reuse

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HIGHLIGHTS

- Raw faecal sludge causes environmental pollution and outburst of diseases.
- Technology options for faecal sludge management.
- The decision matrix prepared with respect to city constraint.
- IRR and payback period were used as financial indicators for treatment technologies.
- Treated faecal sludge has economic and environmental benefits.

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ABSTRACT

This article provides technology options for the treatment of Faecal Sludge (FS) in developing countries to minimise exposure to FS and assesses its benefits along with possible revenue generation from reuse. FS that is collected from septic tanks poses management challenges in urban areas of developing countries. Currently, FS is dumped into the urban and peri-urban environment, posing great risks to the soil, surface water and groundwater quality. FS treatment technology usually consists of (1) primary treatment for the separation of the solid and liquid parts, and (2) sludge treatment, which is the final stage of treatment that is generated from the primary treatment. A decision matrix was prepared on the basis of primary and sludge treatment technological options with respect to land requirement, energy requirement, skill requirement, capital cost (CAPEX), operating cost (OPEX) and groundwater level. These parameters strongly influence the decision-making about the selection of the FS treatment technology. The selection of a FS treatment technology for a city also depends on the local conditions and priorities of the region with regard to sanitation such as population coverage, environmental and health benefits, elimination of open defecation, etc. Techno economic feasibility of different combinations of primary and sludge treatment technologies was conducted to evaluate its viability. The analysis was conducted across different classes of cities with varying population size. The combination of primary treatment technologies with solar sludge oven emerged to be the most economically viable options for FS treatments across different population size in developing countries.

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Contents

1. Introduction

Sanitation refers to the maintenance of hygienic conditions by proper treatment and disposal of excreta. Excreta consists of urine and faeces which are not mixed with grey water. It has low volume but a high concentration of nutrients and pathogens. Inadequate sanitation can lead to the spread of diarrhoeal diseases (Lalander et al., 2013), whereas improved sanitation is known to have a significant positive impact on human health (Mara et al., 2010). At present, there is a lack of access to affordable sanitation facilities in developing countries. FS is the partially digested slurry or semisolid that is generated from the storage of excreta or black water, presence or absence of grey water (Strande et al., 2014). In urban areas of developing countries, about 53.1% of the households do not have a toilet/lavatory and about 38% of the urban households in India use septic tanks as onsite sanitation facility (Census of India, 2011). The faecal sludge collected from these systems is usually discarded directly into water bodies or nearby agricultural fields. This kind of a practice poses great risks to the soil, surface water and groundwater quality, in addition to contaminating the agricultural produce and causing the spread of fatal diseases such as diarrhoea, cholera and helminthiasis due to faecal contamination (Nguyen-Viet et al., 2009).

According to Castro-Rosas et al. (2012), 99% of faecal coliform, 85% of *Escherichia coli* and 7% of diarrheagenic *E. coli* are found in the ready-to-eat salad in Pachuca City, Mexico, where most of the locally consumed vegetables are irrigated with untreated sewage water. The World Health Organization (WHO) recommends that the level of faecal coliforms in wastewater that is used for irrigation should not exceed 1000 Colony-Forming Units (CFUs) or a Most Probable Number (MPN) of 100 ml (WHO, 2006). High levels of faecal coliform were recorded in the vegetables in the markets of Kumasi, Ghana, as they were contaminated by wastewater streams used for irrigation (Keraita et al., 2003).

In developing countries like India, poor nutritional status and poverty promote mortality and morbidity associated with excreta-related diseases. It is estimated that approximately 1.8 million children under the age of five die each year from diarrhoeal diseases worldwide, as reported by the WHO (2004), and 10% of the population in the developing world is severely infected with intestinal worms due to improper waste and excreta management (WHO, 2000). The estimated loss of about 62.5 million Disability-Adjusted Life Years (DALYs) or 4.3% of the overall global burden of disease is mainly attributed to diarrhoeal diseases alone. Unsafe water supply or scarcity of potable water, inappropriate sanitation and poor hygiene are the key factors responsible for about 88% of above estimated diseases (WHO, 2002). A higher risk of mortality has been observed in children with low weight (for their age) (WHO, 2000; Rice et al., 2000). The health impacts of wastewater and FS disposal are mainly due to specific pathogens, e.g., *Shigella* spp. (Esrey et al., 1991). Thus, exposure to excreta is an environmental and health hazard, and so minimising exposure in each and every part of the sanitation value chain becomes