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The business of the honey-suckers in Bengaluru (India):

The potentials and limitations of commercial faecal sludge recycling

IRC International Water and Sanitation Centre

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Left – Honey-sucker tanker in Bengaluru, India; *Right, top and bottom* – Eco-sanitation at play: fertilising farmlands in Bengaluru, India

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The business of the honey-suckers in Bengaluru (India)

The potentials and limitations of commercial faecal sludge recycling – an explorative case study

Occasional Paper 48
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Abbreviations and acronyms

AECOM	Architecture, Engineering, Consulting, Operations and Maintenance
BBMP	Bruhat Bengaluru Mahanagara Pailike – Greater Bangalore Municipal Body
BUDA	Bengaluru Urban Development Authority
BWSSB	Bengaluru Water Supply and Sewerage Board
CAG	Comptroller and Auditor General (of India)
CSE	Centre for Science and Environment
CVP	Customer Value Proposition
EPA	Environmental Protection Act
FS	Faecal Sludge
FSM	Faecal Sludge Management
FYM	Farmyard manure
GoI	Government of India
ICT	Information and communications technology
INR	Indian Rupee (*currency in India*)
IRC	IRC International Water and Sanitation Centre
JSC	Japan Sanitation Consortium
KSPCB	Karnataka State Pollution Control Board
NPK	Nitrogen, phosphorus and potassium
PCB	Pollution Control Board
PHED	Public Health Engineering Department
RTA	Regional Transport Authority
RTO	Regional Transport Office
SANDEC	Department of Water and Sanitation in Developing Countries
STP	Sewage treatment plant
UDA	Urban Development Authority
ULB	Urban Local Body
UNEP	United Nations Environment Programme
UN-HABITAT	United Nations Human Settlements Programme
WASH	Water and Sanitation Hygiene
WASPA	Wastewater Agriculture and Sanitation for Poverty Alleviation
WSS	Water Supply and Sanitation Sector
WWI	Worldwatch Institute
WWTP	Wastewater treatment plant
WHO	World Health Organization

Executive summary

Sustainable urban sanitation for all is the key challenge for the global WASH sector. Large parts of the world's urban population are not served by formal sanitation services, rely on informal services, and/ or defecate in the open. Surprisingly, despite their importance, little is known about informal urban sanitation services, as well as their key actors. This paper presents the findings of a case study in Bengaluru (formerly Bangalore), which investigates the sanitation services provided by so-called 'honey-suckers'.

The majority of the population of Bengaluru is not connected to a sewage system; many relying on a range of informal sanitation self-services. One such method entails constructing holding tanks to store faecal sludge and grey water. These are periodically emptied by vehicles, dubbed 'honey-suckers'; a service provided by small-scale private sector tanker operators.

Most honey-suckers dump their waste in and around the city illegally, in unlicensed locations, causing considerable pollution and health problems. A small percentage however, has started delivering faecal waste to local farmers who use these as fertilisers. As this study will later reveal, the practice of recycling faecal nutrients at scale has emerged without any form of financial or technical assistance.

Though the dumping of untreated faecal waste in this manner operates outside the existing legal framework, it provides a valuable service to those who are not connected to a water-borne sewerage network, while also reducing the scale of indiscriminate dumping. Moreover, tanker operators make a profit while farmers receive free fertiliser. Needless to say, the absence of regulations hampers the scalability and sustainability of a practice that is observed to have wide-ranging benefits.

The findings of this study reveal that the service provided is financially viable, albeit at a small scale, to the extent that it is able to provide a method of dealing with urban sanitation in appropriate circumstances without needing to resort to the construction of sewerage pipes and plant; which are clearly very expensive and hugely wasteful of water.

For a successful service to be brought to scale, recognition and acceptance by urban authorities, and subsequently, its operationalisation within a legal framework, are both required. Complemented by provisions guaranteeing the safety of both honey-sucker operatives and farmers, initiatives addressing issues of safety and the acceptance of consumers are crucial. As most forms of treatment to ensure the safety of consumers and farmers are likely to increase costs, this study finds that (preventive) safety measures are unlikely to be implemented unless there are compelling reasons to do so. Finally, in studying the wide range of sanitation services models, this study recommends for future research endeavours to explore sanitation services based on extraction and reuse, while taking cognisance of the potential solutions for waste and/ or faecal treatment.

1 Introduction

In this case study, the role and capability of entrepreneurs in providing a dual service - that is, serving urban households by emptying holding tanks of latrines and septic tanks, and serving the agricultural sector by providing nutrients to farms – are explored.

The challenge for such entrepreneurs is to be able to successfully combine the provision of an economically viable and sustainable sanitation service to an ever-increasing urban population. At the same time, ensuring that the nutrients accumulating in urban and peri-urban areas are put to good use in agriculture; instead of being released into the environment, causing a range of environmental and health problems.

Disposal of faecal waste leads to a loss of nutrients within the 'nutrient conservation chain'. Additionally, faecal disposal in most urban settings in developing countries takes place indiscriminately, causing major health and environmental hazards for its residents. These are compounded by conditions of chronic hunger. It is the combination of this loss of nutrients, high levels of chronic hunger, and the negative impacts of indiscriminate disposal in urban poor settings that provide a compelling argument for providing and strengthening the nutrient conservation chain; this being the central topic of this case study.

Currently, it is estimated that over 850 million people are chronically hungry (von Braun, 2007; FAO, 2006). At the same time, the earth is losing 25 billion tons of nutrient-rich topsoil annually (WWI, 2005). According to the UNEP (2007), some two billion hectares of vegetated land have been degraded globally since 1945, or 17% of all productively used land.

In order to provide insight into the role and capability of entrepreneurs in providing a dual service, Section 2 presents this study's objectives, its chosen conceptual framework and methodological design. Results generated from the application of the framework and methodology are then presented in Section 3. In Section 4, conclusions and recommendations for responding to the challenges of providing adequate sanitation services to growing urban populations in developing countries are identified, alongside an examination of the concept of human 'waste' reuse.

1.1 On-site urban sanitation

The urban population is set to increase to 4.2 billion out of a projected global population of 7.7 billion in 2020[1], with much of this increase taking place in rapidly growing small and medium-sized towns (UN-Habitat, 2009). This growth is observed to be already putting huge pressure on infrastructure facilities such as water, electricity and sanitation services. In addition, it increases

[1] Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2006 Revision and 2007 revision - http://esa.un.org/unup/ accessed on September 19, 2011.

stress on already under-financed and under-capacitated authorities responsible for urban sanitation service delivery.

In many African cities, less than 15% of urban dwellers benefit from the centralised collection of wastewater (Schaub-Jones, 2005). Of the sixteen West African urban areas with a population of one million or more, Norman (2009) writes that only four have sewerage collection systems serving a significant proportion of the total population, namely Abidjan, Dakar, Conakry and Abuja. These collection systems currently serve about 30%, 25%, 15% and 15% of their respective urban area populations. In Asia, the percentages of un-served population are equally high. For instance, it has been estimated that as much as 98% of the urban population of the Philippines is dependent on on-site sanitation (Strauss et al., 2000). In India, 40% of the 350 million urban dwellers are connected to a sewerage system (AECOM and SANDEC, 2010).

Where piped sewerage is unavailable, urban populations rely on on-site containment in the form of latrines or different types of septic tanks; both requiring transport to off-site disposal locations. It has been estimated that about 2.6 billion urban dwellers currently rely on this combination. In best cases, the faecal sludge is collected and then emptied at a site designated by relevant authorities, where sludge dewatering takes place. However, far more often, faecal sludge is disposed of haphazardly and illegally, leading to pollution of water courses and increasing the risks associated with widespread gastro-intestinal infections (Kone et al., 2009).

Much of the emptying of pit latrines, septic tanks and the disposal of faecal sludge in towns and cities in developing countries are undertaken by small-scale and informal operators in the private sector. Many of whom operate in place of (or supplementing) formal sanitation delivery systems (UN-Habitat, 2009). For example, it has been shown that for three cities in Bangladesh, the coverage of municipal services for faecal sludge emptying varied between 0-1%, with the remainder being covered by informal providers (Opel et al., 2011).

In spite of the large and growing number of urban dwellers served informally, policy makers, local authorities, municipalities, donors[2] and engineers fail to recognise the urgency in improving and expanding the emptying and disposal services provided to on-site sanitation systems as a means to reach those without piped sewerage. Efforts by policymakers and bureaucrats remain focused on networked, water-borne sewerage that does little to improve sanitation in many urban areas; indeed, large tracts of most towns and cities cannot be served in this way, notably low-income urban and peri-urban areas (Schaub-Jones, 2006; Calaguas and Roaf, 2001).

As a means of improving faecal sludge management, one important step made was through calls to formalise collaboration with the private sector service providers (**Box 1**).

[2] Numerous appeals to donors and decision-makers to consider investments in on-site systems to improve and increase service delivery have repeatedly been made (Norman, 2009). Similarly, a call for a paradigm shift towards decentralised excreta disposal systems and technologies, such as on-site sanitation and low-cost sewerage, has also been proposed (Bakir, 2001).

Box 1 Recommendations from the Dakar Declaration on Faecal Sludge Management

A symposium was held on 9-12 May 2006 in Dakar, Senegal, focusing on faecal sludge management (FSM).

Recommendations to policy-makers:

- Define local and national FSM policies, including legal, institutional and socio-economic elements.
- Make faecal sludge management a priority in national and municipal budgets to secure the necessary financial resources.
- Clearly designate a national institution in charge of defining and implementing FSM policies and strategies.
- Enhance and formalise collaboration with the private sector to improve faecal sludge collection, haulage and treatment.
- Promote equipment adapted to slum and/ or peri-urban areas, and improve the protection of personnel engaged in manual and mechanical emptying.
- Intensify training and applied sciences in FSM, focusing on appropriate technologies (design of on-site sanitation facilities, emptying, haulage, and treatment), planning and management, commercialisation and use of FS-derived bio-solids.

Source: Kone et al., 2007.

Valfrey-Visser and Schaub-Jones (2008) emphasised that it is necessary to recognise and formalise commercial services of faecal sludge entrepreneurs in order to improve their capacity to effectively provide services. In order to further develop private sector services for emptying pit latrines and septic tanks, as well as treating faecal sludge, the following steps were outlined by Valfrey-Viseer and Schaub-Jones (2008):

- Support to professional associations of tanker truck operators
- Recognition of and formal agreements with pit and tank emptiers by the authorities
- Innovative financing methods, such as output-based aid, to help provide services to the poorest
- Improved linkage of emptying services with treatment service providers to ensure proper treatment of faecal sludge
- Work on the treatment segment of the service by marketing treatment, finding innovative options for the financing of treatment, dialogue between private investors and public authorities, and discussing new options for waste as a resource

1.2 Nutrients in human waste as a resource

Valfrey-Visser and Schaub-Jones (2008) highlighted new options for considering waste as a resource – this, an important way to develop the treatment segment of the on-site market.

Opportunities lie in capturing and re-using resources, such as nutrients, organic matter, energy and water. This paper is mainly interested in the opportunities that lie in capturing nutrients from sanitation systems, particularly on-site ones.

It is a fact that nutrients in human excreta is already used as a nutrient input into agriculture in different settings around the world, and that its nutrient content represents a real value in monetary terms. The annual value of human excreta from one single person in Niger equals US$ 9. For a family of nine, this translates into US$ 80 yearly. Expressed differently, the value excreted per family per year in Niger is equivalent to approximately 90 kg of chemical fertiliser, which is well beyond the reach of any small-holder farmer in Niger (Dagerskog, 2009).

Over time, local entrepreneurs and farmers in many different places and cultures have recognised the economic value of (raw) human excreta or wastewater. Scott et al. (2004) estimated that approximately 700 million people in 50 countries eat food from crops grown over a total surface area of at least 20 million hectares (ha), which have been irrigated with untreated or inadequately treated wastewater from sewage systems. The reuse of 'night soil' in agriculture used to be a common practice in many countries in earlier times. For example, in Sweden, in the late 19th century to the early 20th century the mixing of sludge produced by emptying latrines in the cities with slaked lime[3] or peat used to take place. Sludge was further processed into a fertilising powder called 'pudrett' (Wetterberg and Axelsson, 1995). Another example is the collection and reuse of 'night soil', practiced on large scale well into the mid-20th century in Japan (Japan Sanitation Consortium, nd). Seidu (2010), Cofie et al. (2010) and Owusu Agyeman and Kranjac-Berisavljevic (2009) reported on the reuse of faecal sludge in northern and southern Ghana. Productive use of human faeces is also reported in Bangladesh (Quazi and Islam, 2008). The farmers' motivation for using faecal sludge, as reported by Owusu Agyeman and Kranjac-Berisavljevic (2009) and Cofie et al (2010), is its fertilising effects, as well as its improvement of soil structure.

These practices, albeit unsafe from a health perspective, have emerged without external support. The faecal sludge thus presents a value to farmers in the sanitation chain, which is explored by on-site sanitation entrepreneurs. However, reuse of faecal sludge or night soil, without taking precautionary measures, can pose health risks to both workers and consumers (Seidu, 2010; Bo et al., 1993).

Faecal sludge and its nutrient content are discussed further in **Box 2** and **Table 1**.

[3] Sometimes known as quick lime or burnt lime, its chemical name is calcium hydroxide.

Box 2 Faecal sludge and its nutrient content

Faecal sludge contains macro plant-nutrients such as nitrogen (N), phosphorus (P) and potassium (K). It also contains so called micro-nutrients. These micro-nutrients are as essential to the plant as the macro-nutrients, but are needed in less quantity for the healthy growth of plants. Cofie et al. (2010) state that the recycling of human excreta can serve the dual purpose of contributing to agricultural production, and integrating waste management in developing cities. One piece in the puzzle of integrated urban waste management is to understand the macro- and micro-nutrient contents of faecal sludge. Strauss et al. (2000) reported that the ammonia content in faecal sludge is usually equivalent to a factor of ten, higher than that in wastewater.

Systematic quantifications of NPK and micro-nutrient content in faecal sludge are, however, scarce. A brief overview of the available data is shown in **Table 1**, which shows the variation in NPK content between different types of faecal sludge; "raw" human excreta, pig and cow manure. Faecal sludge seems to be the closest to cow manure, based on the data.

Table 1 Overview of NPK values of faecal sludge in the literature (selected data)

Source		N % of solids	P % of solids	K% of solids
Sandec report No. 05/ 98	Human excreta	9-12	1.66	2.24
	Pig manure	4-6	1.53	2.28
	Cow manure	2-5	0.79	1.16
Cofie et al., 2009	Dewatered sludge	1.05+-1.02	1.02+-0.36	0.39+-0.41
Cofie et al., 2006	Dried sludge (TS 29%)	2.9+-0.5		
Hedström et al., 1999	Septic tank sludge after freezing and thawing	2.2	0.47	
	Septic tank sludge after freezing, thawing and drying	2.3	0.59	
Kootattep et al., 2004	Sludge dewatered in planted reed bed, upper CW1	3.09	1.95	0.2
	Lower CW1	3.03	1.75	0.19
	Upper CW2	3.14	1.94	0.15
	Lower CW2	2.58	2.68	0.18

1.3 Business model and on-site sanitation entrepreneurs

A simple business model was used to study the latrine-emptying business, and to identify its potential for growth.

A business model, according to Johnson et al. (2008) consists of four interlocking elements:

- Customer value proposition (CVP)
- Profit formula
- Key resources
- Key profits

For the business model to be successful, the four elements should create and deliver value to customers. In the case of service delivery to on-site sanitation customers, it is of interest to use a business model perspective to look at the service delivery provided by on-site sanitation entrepreneurs in order to identify areas for improvement of their activities.

2 Objective and methodology

2.1 Introduction and objectives

This chapter sets out the objectives of the case study; identifies the conceptual framework underpinning the work; and presents the methodology utilised.

The main **objective** of the case study is to come to a better understanding of the potential of reuse of human waste on a commercial basis, and as a driver for improved urban sanitation services.

The following **research questions** explored by the study are:

- What are the costs and benefits for the small-scale service providers that empty septic tanks?
- What are the types of reuse activities of farmers who receive faecal sludge from small-scale service providers?
- What are the potential benefits/ advantages and limitations of commercial reuse of human waste for improved urban sanitation services?

2.2 Business model canvas

As a piece in the puzzle of analysing on-site sanitation entrepreneurs, it is of interest to use a business model for mapping purposes. A business model concept is a structured way of examining a business, and mapping the activities of entrepreneurs and entrepreneurial entities. In this context, enterprises are, most often than not, by definition: profitable, since they would not exist otherwise. Compare this, for example, with municipal services that could provide the same service, but where the decision to provide services is not necessarily based on profit-making. Hence, in undertaking a mapping exercise, it is important to understand first how profits are made; and second how agricultural customers of nutrients in faecal sludge, i.e. farmers, are linked with the households that use the latrine-emptying services.

The challenge is to make the concept simple to ensure that it can easily be applied, but at the same time make the contents relevant in order to meet the dual purpose of: understanding the business, and assessing if and how it can be improved to provide viable and safe services for pit/ tank-emptying, while advancing productive use in agriculture. The business model presented here is based on work by Johnson, Christensen and Kagerman, summarised in a Harvard Business Review article of 2008, and also developed as a tool by Osterwalder et al. (2005).

The idea is to understand the building blocks, and perhaps find the keys to develop the business, or understand obstacles to its further development. The businesses examined by this study are situated in legally difficult and complex environments. As such, formal profit and loss

statements do not exist. Owing to this, the business model building blocks outlined in Figure 1, and explained further in Table 2, was used for the purpose of this study.

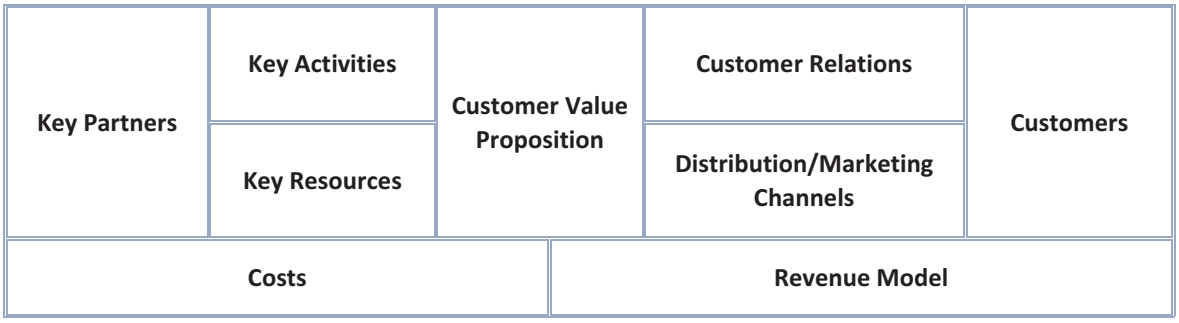

Figure 1 Business model building blocks
Source: Osterwalder and Pigneur, 2010.

Table 2 Explanation of business model building blocks for mapping of businesses

Business model building block	Mapping questions
Customer Value Proposition	What value does the enterprise deliver to the customer? Which of the customers' problems are redressed or solved by the enterprise? Which customer needs are being satisfied?
Customers	Those for whom the entrepreneurs are creating value: Who are the most important customers/ customer segments?
Key activities	How is customer value created?
Key resources	What needs to done to create value profitably?
Key partnerships	Taking for example services provided by a mobile phone manufacturer: Which activities are outsourced and/ or acquired outside the enterprise? Are strategic alliances with an operating system developer being sought?
Customer relations	What kind of customer relations service does each customer segment expect to be established and maintained?
Distribution/ marketing channels	Through which channels do customer segments prefer to be reached? How are customer segments currently being reached?
Costs	What are the associated direct and indirect costs?
Revenue model	How is the model of price and volume organised?

Source: Osterwalder and Pigneur, 2010.

2.3 Case study methodology

As there is limited knowledge on the role of small-scale service providers in the urban sanitation sector (Valfrey-Visser and Schaub-Jones, 2008), this study employs an explorative, case study approach in tackling the objectives set out by the research. Case studies are commonly used in the social sciences as they allow the possibility of generalising results, in as long as it is

understood that the generalisations are of an analytical character, and not statistically proven (Yin, 2003).

2.3.1 Selection of actors and location of case study

The case study was carried out in Bengaluru (Bangalore) – a fast-growing city in South-West India with a population of some 8.5 million, according to the 2011 census. The sole authority responsible for the management of sewage and sullage in the city is the Bengaluru Water Supply and Sewerage Board (BWSSB).

In February 2011, the Comptroller and Auditor-General (CAG) of India reported that the sewage network in Bengaluru served only about 40% of the total 800 km^2 of the city (Hindu, 2011). This implies that only 3.4 million of the 8.5 million population is being served, while the remaining 60% of the city, or 5.1 million people, rely on on-site sanitation with off-site disposal, or are forced to defecate in the open. In Bengaluru, on-site sanitation systems typically consist of septic tanks receiving waste water from toilets, kitchens and showers that are constructed adjacent to, or have some distance from, individual houses. The septic tanks are emptied by informal, private operators, dubbed 'honey-suckers'. Recently, the BWSSB has brought in a system whereby the honey-suckers can dispose of their contents in designated sewage treatment plants, based on a protocol that has yet to be developed. The vacuum trucks are charged a fee of INR 20 (€ 0.30) per m^3 of sludge deposited in the sewage treatment plants. How well this disposal mechanism is functioning today is as yet unclear[4]. The honey-suckers empty their pits/ septic tanks and then, in best cases, dump the faecal sludge at the designated emptying sites managed by the BWSSB. However, most often than not, dumping is reported to take place in vacant plots, or in farms adjacent to the city.

Photo: Bengaluru and Karnataka
http://en.wikipedia.org/wiki/Bengaluru

Bengaluru was chosen as the site for this case study because: (i) it is typically characteristic of on-site sanitation within the city's limits; (ii) there are indications that faecal sludge reuse is taking place on a large scale; (iii) there are previously established relations with a local team of action researchers at Biome Solutions.

During a first field visit, it became clear that intended respondents (farmers, tanker operators, and customers of tanker operator services) were in some cases reluctant to talk about their

[4] Personal communication with an official in the Bengaluru Water Supply and Sanitation Board.

reuse practices. Therefore all respondents were directly or indirectly selected through the network of the local research team. It is recognised that the limited respondent-reach may result in biased result findings. However, given the explorative nature of the case study, this was considered acceptable, in so far that findings are able to provide preliminary insight into the contributions of hone-suckers in responding to the challenges associated to urban sanitation.

This study's data set was collected from four key groups:

- Five small-scale sanitation service providers that empty septic household tanks
- Five farmers who reuse human waste on their farms
- Eleven septic tank owners, served by tanker operators, who were interviewed on consumer issues
- Key informants, such as municipal/ state employees involved in wastewater management

Table 3 Customers using the emptying services at household/ institutional levelprovides a description of the customers who were interviewed for the purpose of this case study. The number of respondents for each type of building is given in brackets.

Table 3 Customers using the emptying services at household/ institutional level

Numbers and types of buildings and customers interviewed	Type of faecal sludge collection unit	Number of people served per unit
Apartment blocks (2)	Wastewater treatment plant (WWTP); some treated water used for landscaping, the rest trucked away after treatment	Approximately 560
	Septic tank	320
Individual homes (5)	Soak pit	14
	Soak pit	4 (2 families of 2 in each family)
	Soak pit	4
	Soak pit	3
	Septic tank	8
Hospital	Septic tank	55
Hotel (2)	WWTP; Sequencing Batch Reactor; some water used for landscaping; tanker trucks are used to empty grease trap and settling tanks	189 (75% occupancy)
	Simple WWTP with grease trap and simple biological step; some treated water is used for landscaping	131 (75% occupancy)
Office	Aerobic reactor, some water used for flushing and landscaping; tankers used for cleaning out settling tanks and grease traps	5,000

2.3.2 Data collection methods and tools

The design of the research methodology and data collection tools was carried out as follows:

1. A two-day design workshop was held to develop the conceptual framework and choose research methods and tools.

2. Research methods and tools selected were tested and later adapted after a field visit in Bengaluru. In parallel, a number of interviews with key stakeholders were held to finalise the methodology and obtain a better understanding of the institutional framework.

3. The local research team of three researchers then collected and tabulated the data over a period of two months.

4. Additional interviews with key informants were carried out.

The following research methods and tools were used for specific respondent groups[5]:

Tanker operators

- Semi-structured interview: Interview covered topics such as different costs and revenues, cost savings for operator emptying tanks at farms (frequency and costs saved), channels (relationship with clients, etc.)
- Venn diagram: Identified stakeholders, and explored relationships with different stakeholders

Consumers

- Semi-structured interview: Interview covered topics such as costs and frequency of services, available sanitation infrastructure, perceptions of relationship with tanker operators regarding the reuse of sludge, etc.

Farmers

- Transect walk on farm: Revealed the types of crops planted, crop-coverage in acres, available infrastructure, overall size of land, and available farming equipment
- Seasonal calendar: Identified the frequency and season of harvest for different crops, frequency and season of manure application, peaks and falls in demand for manure
- Semi-structured interview: Interview covered topics such as perceptions of reuse, costs, costs savings, and revenues, institutional and consumer issues
- Venn diagram: Identified stakeholders, and explored their relationship with the farmers

2.3.3 Limitations of the study design

There are a number of limitations to this study:

- It is exploratory in nature.

[5] A detailed description of all data collection tools can be found in Annex 5 Data collection tools.

- The team drew on existing networks to find respondents, rather than using a statistically-scientific approach in selecting respondents.
- There were a small number of respondents.
- The team actively sought tanker operators who dump faecal sludge on farmland only, thus the data set is by no means representative of how widespread the practice already is.
- The study did not investigate the extent of faecal sludge reuse in Bengaluru, neither did it look at the extent of the population served by the Bengaluru honey-suckers in general.

3 Results and discussion

Mapping of the business model for the emptying and reuse of sludge from sludge holding pits and tanks was done by conducting semi-structured interviews with tanker operators, farmers and customers of the emptying services at the household and institution level. This first results section describes the customers of the emptying services, the channels through which they get in touch with the tanker operators, etc.

3.1 A business model analysis of tanker operators in a large Indian city

3.1.1 The on-site sanitation chain in Bengaluru

The clients of the honey-suckers interviewed in this study have either constructed a large holding tank or septic tank. Large apartment complexes may also have a small sewerage treatment plant. The construction of holding tanks has developed into a separate industry with small-scale contractors that have specialised in the construction of circular holding tanks, with a depth of 6 metres, and a diameter of 1.8 m. In turn, these holding tank constructors are served by small-scale companies that produce concrete rings. There is thus a chain of supply and demand that runs across ring producers to holding tank contractors, households and institutions and honey-suckers to the end users – peri-urban farmers.

3.1.2 The customers of emptying services

The channels through which the pit/ tank-owning customers get in touch with pit emptiers are important for two reasons:

- This market is not officially acknowledged by the authorities. Possibilities for a successful entrepreneur may then be somewhat hampered by the costs of 'being found out by' the customers. Only three out of the eleven customers in this study reported to have found their service provider through formal channels (through the yellow pages, their housing society, and the Pollution Control Board respectively); the majority used their social

network and heard about the service by word of mouth, or saw an advertisement on the tanker(s).

- The fact that some of the customers claimed to have chosen an operator randomly indicates that the market for sanitation services is competitive. But, this can also indicate that stronger relationships with customers have yet to be developed; stronger relations being an important factor in business development. If the tanker entrepreneurs developed a better understanding of sanitation and sanitation technologies within their respective area of operation, a stronger relationship with customers would be a way of expanding their business. For example, the drivers may learn what type of building lay-outs are easily accessible for their vehicles, in order to avoid excessive spilling for instance. In the long run, this expertise could develop the business vertically, by providing advice on the construction of sanitation solutions.

The price paid for services were observed to vary between less than INR 500 and INR 3,000 (less than € 8 to € 49), for the emptying of one holding tank or septic tank. The lowest price was paid by an apartment block, where six to nine tanker trucks empty and take away treated wastewater each day. The highest price was paid by an individual home owner who empties the household's soak pit annually.

All informants were observed to be content with the service provided by the honey-suckers, suggesting that the existing entrepreneurial system meets existing customer demands. However, it is important to remember that this study did not go as far as to investigate whether there are locations or types of constructions that the entrepreneurs do not serve due to inaccessibility, low profit margins, etc. Hence, it is probable that specific categories of the potential customer population may be left un-served.

The majority of the respondents expressed the view that they would be concerned if the contents from the tankers were dumped near or within the city limits. Concerns mentioned were the risk of water pollution, the creation of stagnant water bodies, and the unwillingness to have the sludge emptied on plots nearby their own dwellings. As one informant explained:

> "*Yes – It would concern me if they were dumping it into the lakes. However, I would be very glad if they were dumping it on farms and using it as manure. In fact I had planted a papaya tree near my pit and it gave more fruits than any other papaya tree that I have known. I wonder if there was any connection".*

Production of rings of holding tank
Photo: V. Srikantaiah

Seven out of the eleven respondents of the study did not know where the faecal sludge from their septic tanks/ treatment plants/ pits being taken. The remaining four registered knowledge on where the sludge was being taken: to farms, or in one case, to a farm or an empty plot. Seven out of eleven answered positively

to the question "Would you be willing to pay 50% extra to make sure that the sludge is disposed of in a safe place?" One respondent said: *"*I would pay him [the honey sucker] to dump it [the sludge] in my fields. He won't charge 50% more. It's only 2 km away from my home*".*

However, a positive answer does not necessarily indicate that respondents have the willingness to pay more for an entrepreneur who guarantees environmentally sound treatment, and who monitors safe practices for reuse of faecal sludge. Nonetheless, the positive answers to this question do indicate that there is, at least in the long run, room for entrepreneurs to implement environmentally orientated practices in their customer value proposition.

3.1.3 Business model analysis

A summary of the data collected from the semi-structured interviews with the tanker operators is found in Annex 3 Summary responses tanker operators. Four owners of emptying businesses and one driver working for a fifth tanker operator were interviewed for the business model analysis. Four of the five respondents (all owners of tanker operator businesses, not the driver) mentioned that good money in the business is the primary reason why they entered the market. Two of the four respondents added however that there is a problem with staff turnover (labourers do not stay in the job for long periods of time); another respondent exclaimed that he "would not want his children to take up the same business". Another owner expressed concern over the construction of sewer lines, which he claimed, may destroy his business; as a result he is currently thinking of moving out of the market.

The businesses seem small: three of the respondents work with one truck only, while the largest player has eight trucks in possession. Only two of the respondents reported paying tax, indicating that the operators are working in an extra-legal environment[6].

One interesting feature of the tanker operator business is that the market for emptying latrines actually creates a potential market for returning nutrients to agriculture. In this particular case, a **two-sided business model** is apparent: one that provides a service **of emptying latrines as the primary market**; and, one that provides **fertilisers to the benefit of farmers, as the secondary market**. Within this model, the secondary market is highly dependent on service delivery to the primary market.

The different elements of the business model are discussed in more detail below.

3.1.3.1 Customer Value Proposition (CVP)

The CVP in the primary market for the removal of faecal sludge is that the customers want functioning latrines and cleanliness around their property. In the secondary market – the dumping and use of the faecal sludge – farmers want nutrients and water for their fields and crops. In a general sense, when talking about CVPs, the value obtained may be described

[6] This paper makes use of the term extra-legal and not 'informal sector' to emphasise that operating outside the legal framework leads to additional costs for entrepreneurs and hampers long-term sustainability.

quantitatively (price, speed of delivery) or qualitatively (design, customer experience). This is more or less an infrastructure service; hence, focus on the quantitative values seems warranted.

Honey Sucker
Photo: V. Srikantaiah

However, in the long run, providing continued service to a developing and increasingly wealthy community may place increased emphasis on the cleanliness of the operation, design or perceived cleanliness of the trucks, appearance of the drivers/ personnel, environmental services, etc. The operator charging the highest price for emptying was also the only respondent who was identified as providing a quality service, e.g., upon receipt of a phone call, the truck will be on the spot within an hour, and the job done in fifteen minutes. This indicates that there is a demand for high quality services. This is further validated by customer-respondents' stated willingness to pay a higher price if the tanker operator could offer the environmentally safe disposal of the sludge. However, in the near future it seems unlikely that improving the quality of services offered will be chosen by tanker operators to enlarge their market share.

3.1.3.2 Customers

Two sets of customers can be defined: septic tank users, and farmers. In the case of septic tank users, the tanker operators provide a mass market service, but with a somewhat restricted geographical reach, since the customers who want their latrines emptied face broadly the same needs and problems. For the farmers (the second set of customers), the tanker operators act as the link between them and the septic tank users.

3.1.3.3 Key activities

The key activity in the first market is the emptying of latrines in households and institutions; and for the second market, the emptying of faecal sludge in farms. One key activity is/ could be in the form of relationship-building with farmers, see section 3.1.3.4 below.

3.1.3.4 Key resources

What key resources does the CVP require? What resources do the distribution channels call for? And what is needed to keep good customer relations with both individual property owners and farmers?

There is no doubt that in terms of resources, the fleet of trucks is crucial. In addition, the enterprise needs a driver and a helper per truck to run the services. For the secondary market in particular, the network of these drivers with individual farmers that allow reuse of the sludge should be seen as an asset.

Findings of the study suggest that relationships are stronger between the drivers and the farmers, rather than between the tanker operating business proper and the farmers. Three out of the five respondents mentioned high turnover of staff as a problem for their businesses. Interestingly enough, these are the three operators who have the least faecal sludge that go to farmland. Thus, the two operators emptying all their sludge onto farmland are also the two businesses which manage to retain their staff better. Lower turnover of staff in the case may be explained by the extra pay truck drivers and helpers receive in emptying sludge onto farmland; the occasional INR 100 per load mentioned, somewhat reluctantly, by the only driver interviewed. However, the driver also mentioned that the "owner of the business was kind, friendly and that he had been with him for four years" - the relationship between drivers and owners is clearly also of importance in retaining staff[7].

3.1.3.5 Key partnerships

Emptying of holding tank
Photo: Vishwanath

No key partnerships were identified during the interviews with the tanker operators. However, key partnerships could be formed through, for example, tanker operators sharing some facilities, e.g., a garage or truck maintenance with another transport company. In the long run, one could think of building/ strengthening partnerships between the honey-suckers and the builders of latrines to develop better functioning septic tanks. This lack of partnership is likely to be due to the extra-legal character of the honey-sucking business; this leading to higher transaction costs. Further, the current institutional setting seems to push operators towards prioritising short term profitability, over long term possibilities. Such does not encourage business innovation. The transaction costs of maintaining key partners are also likely to be considerably higher in an extra-legal system such as the one being explored by this study. Thus 'blanks' found in the model is probably due to the deficiencies in the institutional setting.

Within the business model, the farmers could potentially be seen as key partners. For the purpose of this study however, farmers are considered as secondary customers. As such, they pay a price for the sludge supply services – this varies from nothing at all to a tip to the driver. Clearly, however, the distinction between a key partner and a customer in the secondary market, as in this case, is blurred.

[7] Note that the study does not provide a full understanding of potentially different perspectives of tanker operators and drivers.

3.1.3.6 Channels

Based on the interviews conducted for this study, the main marketing approach and channel used to service the primary market seems to be a passive one (e.g., word of mouth from one customer to another, advertising on trucks, etc.). Channels used for the secondary market – the farmers – seem to go through the drivers. In their struggle to find a location where truck loads may be emptied, the drivers take the initiative to find farmers who are willing to accept faecal sludge on their land. This channel and how farmers are being reached by drivers is an interesting subject that should be explored, if increased interaction is going to be sought. However, interactions can only be improved when accompanied by efforts to redress the impediments to the legal recognition of honey-suckers.

3.1.3.7 Customer relations

This study found no evidence of long-lasting or special relationships established between customers and tanker operators in the primary market. At the moment, the households only expect to get their latrines emptied on a needs basis, at a 'reasonable' price and with good and speedy service delivery (response time and time on-site).

Currently, information and knowledge on the business potential of emptying latrines is still lacking, at best, this remains at the level of speculation. With honey-sucking considered an official and regulated delivery of services, there may be an increased understanding of the business potential of services building 'smart on-site systems' may be achieved. Such would facilitate an examination of, for instance, systems that accommodate handling of the waste and protecting the environment, while also serving different types of houses, businesses and institutions, offering 'maintenance' of septic tanks, etc. Provided that there is land available, another potential development strand for the honey-suckers is in the domain of offering services to dry faecal sludge, selling this to farmers. However, at this stage the business and developmental potential of honey-suckers does not reflect a mapping of today's realities, rather, a proposition of what may be achieved.

Nevertheless, it is expected that more relationship marketing with the farming community in the near future, with at least implicit contracts for delivery, will take place. The honey-suckers' customer base could also be enlarged through activities that inform farmers on how to use the faecal sludge, with minimal health risks. As explained earlier, this would probably be easier if a simple legal framework for reuse were set in place. Such a framework could serve as the foundation for the enforcement of contracts, simple monitoring etc. As Cofie et al. (2010) explained there is a necessity to set up an integrated strategy to see through the implementation of a programme for the use of human excreta in agriculture successfully; they also recommend policy support for such productive use, and the provision of proper education for those who use human excreta in agriculture.

3.1.3.8 The revenue stream

In a legal business, examining profit and loss statements will show the profitability of the business. As the honey-suckers operate within an extra-legal framework, approximating profit and loss statements were conducted through semi-structured interviews with the tanker operators. As the figures obtained cannot fully inform a proper profit and loss analysis, Table 4 is limited to providing an overview of the range of costs and revenues. Not discounting the fact that tanker operators do make a profit (otherwise they would not be in business); the data provided should be considered as indicative and insufficient in facilitating real calculations of annual profits. During the interviews, all owners of businesses confirmed that there is good money in the honey-sucking business. In one case, farmers were report to pay the driver to access the faecal sludge. In real terms however, this study is unable to provide clarity on the amount of money paid to the driver, and the extent to which tank owners benefit from this type of payment.

Table 4 Estimated revenues and costs for tanker operators (N = 5)

Revenues	Charge at emptying	Charges vary from INR 800 to 3,000 per emptying trip
	Number of customers per day	Three to four customers per day; during the monsoon season (based on one operator respondent) – up to six to eight customers per day
Costs	Capital costs, office space, equipment	None of the tank operator respondents had offices; the costs of trucks vary from INR 400,000 (used truck) to INR 1,700,000 (new truck)
	Fuel costs per month per vehicle	INR 12,000 to 30,000
	Yearly maintenance costs	INR 10,000 to 5,000
	Salary costs per month	Varies from INR 3,000 to 15,000 per driver/ helper
	Overhead costs	One owner mentioned the interest rate on a loan for buying a tanker truck and another for the monthly costs for a second-hand permit
	Costs of legal disposal of sludge	INR 8 to 12 per 1,000 litres; only two operators mentioned legal disposal costs

Set within a more conducive legal framework, the study's findings suggest that honey-sucking entities may be able to make more money by rendering additional services surrounding latrine activities. Increased possibilities for profit-making may be facilitated if there is access to the relevant knowledge on the pros and cons of different solutions.

Based on interviews conducted with the entrepreneurs, findings suggest that a 'focal price' is set – meaning, entrepreneurs have his or her own view of what constitutes as fair pricing; this is the price reported in the study's survey. Nonetheless, it is not far-fetched to assume that

dynamic pricing, i.e. bargaining, also takes place. However, since the market is 'below the radar', it is hard to assess how much bargaining power each party really has, and how consistent this might be. As such, the impact this might have on overall revenues is unknown.

In a study by Mbéguéré et al. (2010), they concluded that entrepreneurs in Dakar, Senegal could not live off emptying faecal sludge alone. In order to increase profits, entrepreneurs were reported by Mbéguéré et al. (2010) to use their trucks for additional activities, such as storm water drainage and hydrocarbon emptying. Blunier (2004) showed that it was difficult for an operator in a town in Burkina Faso to make a profit from existing emptying fees, which from the end of the consumers – were already considered too high. Steiner et al. (2004) suggested that one way of lowering emptying fees was to give entrepreneurs a sum per load emptied at the treatment plant.

In contrast, profitability does not seem to be a problem in Bengaluru. All business owners confirmed in the interviews that they considered their current business to be good. However, the absence of a proper and well-maintained accounting system makes it impossible to arrive at precise statements about the revenue streams, and actual profitability of the honey-sucking business.

In terms of price setting, findings derived from the study's consumer survey indicate that the customers feel they receive value for their money, although prices vary considerably across operators. It must further be noted that tanker operators may well be avoiding certain areas in the city, e.g., low-income areas where people cannot afford to pay for the emptying services.

3.1.3.9 Cost structure

Drying pit for faecal sludge
Photo: V. Srikantaiah

The fixed and variable costs for the trucks and the salaries of the drivers are the main costs for the tanker operators. However, there are also costs associated with being an extra-legal business; those mentioned by the respondents were bribes and costs of, sometimes second-hand permits and licences. Which types of licenses are needed from which institutions, and what their duration, cost and rules are, remains unclear.

Being an extra-legal business in India is nothing unusual; the informal sector is larger than the formal sector. In general, there are three main areas where working with an extra-legal framework may be problematic. First, businesses have to devote efforts to avoid punishment. They are also exposed to pressures of paying 'protection money' or making bribes; a fact that was also confirmed by some of this study's respondents. Second, the informal sector, in general, transfer resources to the formal sector without being able to use the scope and benefits of the formal sector. Third, informal sectors

have to absorb the consequences of not paying taxes or following environmental or labour laws. There are some costs incurred in avoiding penalties. The extra-legal business owner saves him/herself from paying the costs for compliance, but assumes the costs of avoiding penalty payments. Trends within the informal sector, in general, also reveal that it is under-capitalised, not only because it is both difficult and expensive to obtain credit, but also because a large capital stock is easier for the authorities to detect. In addition to the avoidance of penalties, extra-legal businesses are often operating on a sub-optimal scale (De Soto, 2000); this is also validated in this study, given the small-scale businesses of the respondents.

Another study found that the lack of institutional support and funding mechanisms were perceived to hamper the up-scaling of mainly NGO-driven faecal sludge management initiatives in Bangladesh (GHK, 2005). Another factor mentioned is the fragmented nature of demand. Compared to other service providers in the water sector – such as water vendors – the services of a service provider for faecal sludge emptying are needed infrequently, and at large intervals only (Southern Africa Knowledge Node on Sanitation, 2011).

Emptying of tanker
Photo: V. Srikantaiah

Those engaged in extra-legal businesses do not have access to trade fairs or stock markets. Instruments of trade such as warrants and letters of credit may fall outside the scope of these entities. The costs of gathering information about potential business partners is higher, as there are generally fewer brand names or other guarantees profiling the latter's credibility. Thus, efficient firms may be barred from expanding their businesses, just because they cannot find and reach customers, and cannot use other expansion mechanisms generally employed by owners within the formal sector. Extra-legal business owners indirectly pay taxes, such as gasoline tax, without receiving benefits from the formal economy. Most often than not, their assets are kept in cash, in effect, making them more vulnerable to the shocks of inflation. The inability to obtain credit in the formal sector also results in extra-legal business owners paying a 'risk premium' over and above the amounts that legal entities pay for credit.

Finally, there are some costs to not paying taxes or adhering to relevant laws. No doubt, working within an extra-legal environment does have economic benefits –l the informal sector may pay wages below the legal minimum rate, for example) – but this to have consequences. For example, such prevents them from accessing state-of-the-art technology instead they are locked-in to using low technology equipment, resulting in comparatively lower productivity. On the other hand, they can hire and fire employees at will when necessary. However, companies within the informal sector do not benefit from, for example, tax deductions that may be

available for companies in the formal sector. One example is the value added tax that informal sector companies pay when purchasing goods; legally- constituted companies enjoy tax breaks and deductions, those in the informal sector do not.

3.2 The business of re-using human waste

This section summarises the findings of the semi-structured interviews with farmers, which focused on the advantages and disadvantages of faecal sludge reuse, and their relationships with tanker operators. The summary of the semi-structured interviews with the farmers can be found in Annex 4 Summary response of farmers.

3.2.1 The second set of customers: the farmers

Most of the farmers selected for the interviews were growing a wide-variety of crops for selling, and were those who employed a number of farm labourers. The size of their land varied between 0.4 and 2.0 ha. Crops included coconut, sapota (chickoo, an Indian fruit), arecanuts (the seed of the areca palm tree), bananas, paddy (rice), tomatoes, beans, flowers and vegetables. Four out of the five farmers interviewed sold their produce to wholesalers.

The farmers use two methods in applying faecal sludge to their crops:

- Faecal sludge from the honey-suckers is emptied into a large pit. After the sludge has dried (usually in about three months), it is applied to the crops, e.g., to coconut trees. The water from the sludge either infiltrates or evaporates.
- Wet faecal sludge is directly applied to the farm land. This is done either through trenches (for instance, in between banana trees), or on vacant farmland that will be farmed later in the season.

One of the farmers interviewed also sold dried faecal sludge to other farmers. For this purpose, he created one large additional pit on his land.

3.2.2 Use of faecal sludge and the relationship with tanker operators

Three out of five farmers mentioned that the use of faecal sludge as fertilisers has been practised for a long time, and was passed on to them by their parents. From their perspective, there are no barriers to using human waste in agriculture[8]. Tanker operators do not use any formal marketing channels to identify farmers for the dumping of the faecal sludge. In two cases, farmers were approached by tanker operators, the other two farmers were invited, whilst the fifth farmer mainly used faecal sludge obtained from his large extended family.

During the interviews, the farmers made no mention of receiving sludge from solely one or a selected number of honey-suckers, nor were payments for the faecal sludge were reported. In

[8] It needs to be noted that only farmers who reuse faecal sludge were interviewed and hence a random sample amongst farmers might give a different perspective.

contrast, most truck drivers interviewed suggested to work within a network of farmers known to them, and the one driver interviewed (the others interviewed were all owners of their respective tanker businesses) mentioned accepting payments from farmers for truckloads being emptied on farmland.

3.2.3 Advantages and disadvantages of the use of faecal sludge

All farmers interviewed in this study were content with the fertilising value of the faecal sludge:

- Four out of the five farmers interviewed mentioned that their yield has gone up with the use of faecal sludge.
- One farmer said that the faecal sludge is more efficient than using farmyard manure (FYM), and that he needed only half as much dewatered faecal sludge compared to FYM for the same yield. Perhaps, this is explained by the common FYM management in the area, where the solid parts are collected, mixed with leaves and hay, and allowed to decompose before being applied as fertilisers. The high N-containing urine fraction is thus probably lost.

Increased income amongst farmers using faecal sludge has been reported in several publications. Cofie et al. (2010) found that the use of faecal sludge by farmers in Southern Ghana led to an increased net income of US$ 266 per hectare of farm land. They identified a combination of increased yields and decreased production costs as the two main factors behind the income increase.

Table 4 shows that cost savings are related to a reduction of costs in fertiliser, as farmers obtain faecal sludge free of costs from the tanker operators. Two of the farmers mentioned that the use of faecal sludge also seem to result in higher water consumption. However, this was not mentioned as resulting in any significant increase in costs. While this study did not explore the agricultural aspects of faecal sludge reuse, a review of related literature suggests that the nutrient characterisation of faecal sludge, as well as its agricultural value, has not been thoroughly investigated. Thus, there is a need for further research to understand these aspects better.

The farmers interviewed confirmed the positive financial impacts of using faecal sludge instead of farmyard manure. According to them, their total financial gain in a year's time (in terms of savings) is estimated to range between INR 8,000 to INR 170,000 (€ 130 to € 2,830)[9] each. For the farmer who also sold dried faecal sludge to other farmers, he estimated his earnings at INR 1,500 (€ 25) per tractor load of dried faecal sludge, totalling to approximately INR 450,000 (€ 7,300) annually.

[9] The estimated savings are based on the difference between (i) the costs of purchasing Farm Land Manure plus the labour costs of applying it; and (ii) the costs of purchasing faecal sludge (this mostly comes at no costs), as well as labour costs in applying it. It needs to be noted that the labour costs of applying faecal sludge are less, due to the higher concentration of nutrients.

3.2.4 Health impacts from the reuse of faecal sludge

Reuse of non-treated faecal sludge can pose health risks to those working in the fields, as well as consumers of agricultural produce. Raw sludge typically contains harmful micro-organisms such as viruses and bacteria in large quantities. Contact to these can transmit diarrhoeal diseases, intestinal worms, hepatitis A and cholera, as well as skin and eye infections.

Incidences of faecal-oral diseases were not mentioned by the farmers – this of course does not discount the fact that diseases do occur amongst field labourers. Two out of the five interviewed however, acknowledged that field labourers suffered from boils on feet when raw faecal sludge was applied. One farmer mentioned that his labourers refused to handle faecal sludge.

For faecal sludge to be of practical use, Seidu (2010) argued that sludge application guidelines need to be regionalised, and derived from local practices. Seidu's (2010) investigation addressed health risks associated with on-farm traditional faecal sludge treatment methods in northern Ghana. Two traditional sludge drying methods were investigated: (i) random spot spreading and (ii) pit containment; methods traditionally employed by farmers in Northern Ghana to process sludge into 'cakes' before soil incorporation. Sludge drying for more than 60 days in the random spot spread, and more than 90 days using the pit methods were found to meet the World Health Organization's (WHO) monitoring benchmark for *Ascaris* and *E. coli* with respect to sludge application. These measures are thus recommended to safeguard farmers from rotavirus and *Ascaris* infections. Further risk reduction can be achieved by encouraging farmers to wear protective clothing during sludge handling.

Departing from Seidu's (2010) work, the development of regionalised recommendations for faecal sludge reuse is recommended for Bengaluru (or Karnataka), based on the examination of current practices of (i) direct use, (ii) storage in pit, and (iii) spreading on farmland in ley (random-spot application). For future studies, investigating how these practices can be combined with compliance to the WHO's monitoring benchmarks for Ascaris and E. Coli should also be carried out.

3.2.5 Legal framework and consumer perceptions

None of the farmers were aware of the legal framework that governed the use of faecal sludge; only one farmer had received a legal notice from the local authorities regarding its use[10].

In many countries, there is a negative perception about the use of faecal sludge. For instance, in Rajshahi, Bangladesh, crops that are grown with wastewater are sold for a lower price in the market[11]. However, all the farmers in this study are selling to wholesalers, and none of them mentioned any negative repercussions from wholesalers regarding their practice of using faecal sludge as crop fertiliser.

[10] The same farmer lived close to the city and dug a large pit on his land to store dry faecal sludge for selling. He suspected that his neighbours – who had seen his pit – had notified the local authorities.

[11] Personal communication with Joep Verhagen during the Water Agriculture Sanitation Poverty Alleviation Wastewater Agriculture and Sanitation Poverty Alleviation? See: http://www.iwmi.cgiar.org/waspa/WASPAprojinfo.htm

4 Conclusion and recommendations

This explorative case study described the faecal sludge tanker operator business in Bengaluru, the capital of the state of Karnataka in India – which also enjoys a major seat in the (inter)national ICT industry – using a business model developed by Osterwalder and Pigneur (2010). Bengaluru has a population of about 8.5 million, and approximately 60% of the population relies on on-site sanitation services, including septic tank/ pit emptying by private tanker operators. The tanker operators in Bengaluru who empty their sludge on farmland – interviewed for the purpose of this study – have two sets of customers: (i) the septic tank or pit owner; and (ii) the farmers where the sludge is disposed. In this case, the tanker operators employ a two-sided business model: with the second side of the model, the provision of nutrients to farms, being dependent on the first side of the model, the emptying of faecal sludge from septic tanks/ pits.

The business model analysis resulted in a number of recommendations on how the tanker operators' business can be improved. These recommendations are summarised in Table 5.

Table 5 Summary business model – the way forward

Item	Suggestion of development	Obstacle
Business model developments	Improve cleanliness of operation	
	Emphasise environmental services	Emptying fee should not be too expensive
	Create a network of farmers, resulting in the development of the secondary market	
	Improve relationships between the owner and staff	
	Strengthen the relationship between the drivers and the farmers	Potentially extra-legal activity
	Enhance the service level provided, and offer better latrines	Legal and policy recognition of reuse necessary for establishment of contracts, risk assessment, information material etc.
	Dry and sell faecal sludge	
	Reduce the health and environmental risks of sludge reuse at farm level by training farmers how to use faecal sludge safely	
	Monitor reuse	
	Widen the means to finance key resources	Non-legal status
Further investigations	Study the relationship between the drivers of tanker trucks and farmers	
	Understand how much of the demand for emptying services is actually met by the tanker operators in business	

Item	Suggestion of development	Obstacle
	Study which legal and regulatory steps must a tanker operator business take in order to start a legal business	
	Understand better the dynamics between the sewerage utility and the tanker operators: e.g., the reasons behind why the sewerage utility does not consider alternative options for service provision, other than the expansion of the sewer lines	

From the farmers' point of view, the reuse of faecal sludge decreases their costs as faecal sludge replaces farmyard manure and/ or chemical fertilisers. Financial gains from the use of faecal sludge are estimated between INR 8,000 and INR 170,000, or € 130 to € 2,830 per year. One farmer who dried sludge and sold this to other farmers was found to have an additional yearly income of INR 450,000 or approximately € 7,300. Four out of the five farmers mentioned that their yield had increased with the use of faecal sludge as a fertiliser. In general, all of them were content with the fertilising value of faecal sludge. None of the farmers registered any reluctance in using faecal sludge for their crops, nor did they mention that their direct clients – the wholesalers – were not willing to buy their produce. However, some farmers did raise concerns over labourers experiencing skin problems, or refusing to handle sludge. Moreover, health risks linked to crops fertilised by faecal sludge remain largely unknown.

The informal sector service model for faecal sludge collection, disposal and use in the urban sanitation chain has come into existence without any financial or technical assistance. Overall, it was found to be a financially viable service model; at least to middle-class households, which are not connected to the main sewerage network. Faecal sludge use by farmers was reported to have added benefits in terms of costs savings, potentially serving as an added income-generating activity, and increasing crop yield. From an environmental perspective, faecal sludge reuse also seem to have reduced the burden and pressures on the environment, while at the same time recycling nutrients back into the soil. However, despite the benefits reported, in so long as the service continues to operate outside a legal framework, the largely uncontrolled dumping of faecal sludge in its present form will prove unsustainable.

The findings of this study suggest that there are good opportunities to develop the service into an alternative for large-scale urban sewerage services, with sludge treatment plants. This would be most applicable if the utilities responsible for urban sanitation would consider the services that are already operating (within a non-networked area), and use these as the basis for improving service delivery, rather than automatically seeking to expand sewer networks.

As an explorative study, it is however clear that there is a need for further research into better understanding the tanker operators' business in Bengaluru. It is also recommended that similar studies to this one are carried out in other cities in India and South Asia to understand in more detail, the on-site sanitation cost-structures and relationships between stakeholders. This

applies in particular to cases where use of faecal sludge exists in a situation where tanker operators form the link between households/ institutions and farmers, in different contexts.

In the case of Bengaluru (or Karnataka), it is recommended that regionalised guidelines for faecal sludge reuse are developed, taking into account the current local practices of: (i) direct reuse, (ii) storage in pit, and (iii) spreading on farmland in ley (random-spot application). Furthermore, the development of regionalised guidelines should be complemented by a study ensuring that current practices meet the WHO monitoring benchmarks for *Ascaris* and *E. Coli*.

Finally, since this study did not examine the agricultural aspects of faecal sludge reuse, and noting that the nutrient characterisation of faecal sludge (as well as its agricultural value) has yet to be sufficiently investigated, further research to understand these aspects better will be of great benefit.

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Annexes

Annex 1 The case study context

This section provides an inexhaustive overview of a number of key policies, regulations, and key stakeholders. In the context of India, as others, it must be noted that there may be a significant gap between policies and implementation. In many cases, urban authorities lack adequate means to implement and/ or enforce existing policies and regulations.

A1.1 Urban governance structure in India

The urban governance structure in India is highly complex with weak, overlapping mandates. This section briefly describes the urban governance structure in Indian cities. It concludes with some observations on the predominant importance of informal governance and patronage systems.

The Seventy Fourth Amendment Act (1992) makes it obligatory for State Governments to set up Urban Local Bodies (ULBs). Depending on the size of the city, these are known as Municipal Corporations, Municipal Councils or *Nagar Panchayat*. The Municipal Corporations in large and mega cities enjoy more autonomy in their dealings with the State Government, than Municipal Councils and Nagar Panchayats. They are allowed to levy taxes, such as a property and vehicle taxes, and for services such as water supply, garbage collection and street lighting. Municipal Corporations consist of two wings:

- The Municipal Council with elected councillors representing city wards and headed by a Mayor.
- The Executive Wing, formed by the Municipal Commissioner, who is an Indian Administrative Service (IAS) officer appointed by the State Government.

The second important player is the Revenue Department or Collectorate headed by the District Collector. The District Collector is appointed by and reports directly to the State Government. Amongst other things, the Revenue Department is responsible for: (a) land survey and land records; (b) control of land use and collection of land tax; and (c) control over urban water bodies. The Irrigation Department is under the purview of the District Collector.

The third important urban authority is the Urban Development Authority (UDA). Originally, UDAs were entrusted with the development of master and zone development plans for their areas. In many cases, these development zones do not correspond with the boundaries of the Municipal Corporation. The UDAs were brought into existence to coordinate urban development at the State Level and to compensate for the presumed lack of capacity of ULBs. UDAs directly report to the State Departments. This and the fact that UDAs have taken over a number of responsibilities from the Municipal Corporations has created a certain level of hostility between UDAs and ULBs in many cities.

Finally, there are the Members of the Local Assembly (MLAs) who dominate the political scene. They have their respective constituencies and need to build their support including, in some cases, by providing favours to their electorate (Baken 2008).

The result of these institutional complexities combined with a lack of funds is what Baken (2008, p.2) describes as:

> *"Local governments operate in 'an implementation muddle', demanding improvisation, flexible interpretation, and inviting the bending of rules and corruption. Since there is hardly any corrective feedback, the muddle tends to get larger and deeper".*

The main actors in this "muddle" are the local and State politicians, the administrators, and the un-elected slum- and neighbourhood leaders, and land brokers. The result of this muddle is that urban planning and service delivery can serve the interests of the different power brokers rather than the interests of the urban population.

In the urban Water Supply and Sanitation Sector (WSS), a 2006-World Bank report notes (in AECOM and SANDEC 2010, p.38):

> *"In urban [water supply and sanitation] there is often a unhealthy overlap between policymaking, regulation, financing, ownership of infrastructure and operation of service within State agencies responsible for the two sub-sectors".*

A1.2 Urban sanitation services in Bengaluru

According to the census of 2011, Bengaluru has a population of nearly 8.5 million people. With an average household size of around 4.5 persons, according to the Comprehensive Development Plan of 2011, there are approximately 1.9 million households in the city. The sole authority responsible for the management of sewage and sullage in the city is the Bengaluru Water Supply and Sewerage Board (BWSSB).

The National Sanitation Policy Document prepared by the Ministry of Urban Development of the Government of India (GoI) requires each city to produce and publish a City Sanitation Plan. Amongst others, the goal of this national policy is the safe and sanitary disposal of 100% of human excreta and liquid wastes from all sanitation facilities, including toilets. The sludge must be disposed of safely by:

- Promoting proper functioning of network-based sewerage systems and ensuring connections of households to them wherever possible.
- Promoting recycling and reuse of treated waste water for non-potable applications wherever possible.
- Promoting proper disposal and treatment of sludge from on-site installations (septic tanks, pit latrines, etc.).
- Ensuring that all the human waste is collected safely, confined and disposed of after treatment, so as not to cause any hazard to public health and the environment.

At the time of this case study, the BSWWB mentioned that they were not aware that a City Sanitation Plan for the City of Bengaluru was being developed[12]. The Urban Drinking Water and Sanitation Policy, Karnataka, made no mention of the honey-sucker model of septic tank sludge management at all.

The Ministry of Urban Development of India indicates that 37.6% of properties in Bengaluru are connected to the sewage network (GoI, 2009). It is estimated that around 55% of the generated waste water in Bengaluru is treated (GoI, 2009). The remaining population needs to rely on different forms of self-service for human excreta disposal, mostly as a combination of on-site containment and off-site disposal, or open defecation. This study focuses on one specific self-initiated 'solution': a combination of holding tanks or soak pits for grey and black water that individual households have had constructed at some distance from the house, in many cases under public roads. These tanks/ pits are regularly emptied by so-called honey-suckers. These honey-suckers dump their waste illegally on vacant plots and on the land of farmers around the city.

In February 2011, the Comptroller and Auditor-General (CAG) of India reported that the sewage network in Bengaluru served only 317 sq. km. or 39% out of the total 800 sq. km. of the city. The Karnataka State Pollution Control Board (KSPCB) admitted in its reply to the CAG that 53% of the sewage generated is directly discharged into the environment without any form of treatment. Moreover, the CAG reported that the 17 sewage treatment plants (STPs) in the city are functioning well below their capacity. In the period 2005 – 2009, the 17 STPs treated 251 ml/ d (million litres per day) against an installed capacity of 781 ml/ d (Hindu, 2011).

A1.2.2 Key institutions and regulations on urban sanitation

This section describes the key actors, policies, and regulations for urban sanitation services in Bengaluru that are particularly relevant for the focus of this case study. Figure 2 illustrates the urban sanitation chain and its key actors.

[12] Source: personal communication with BWSSB.

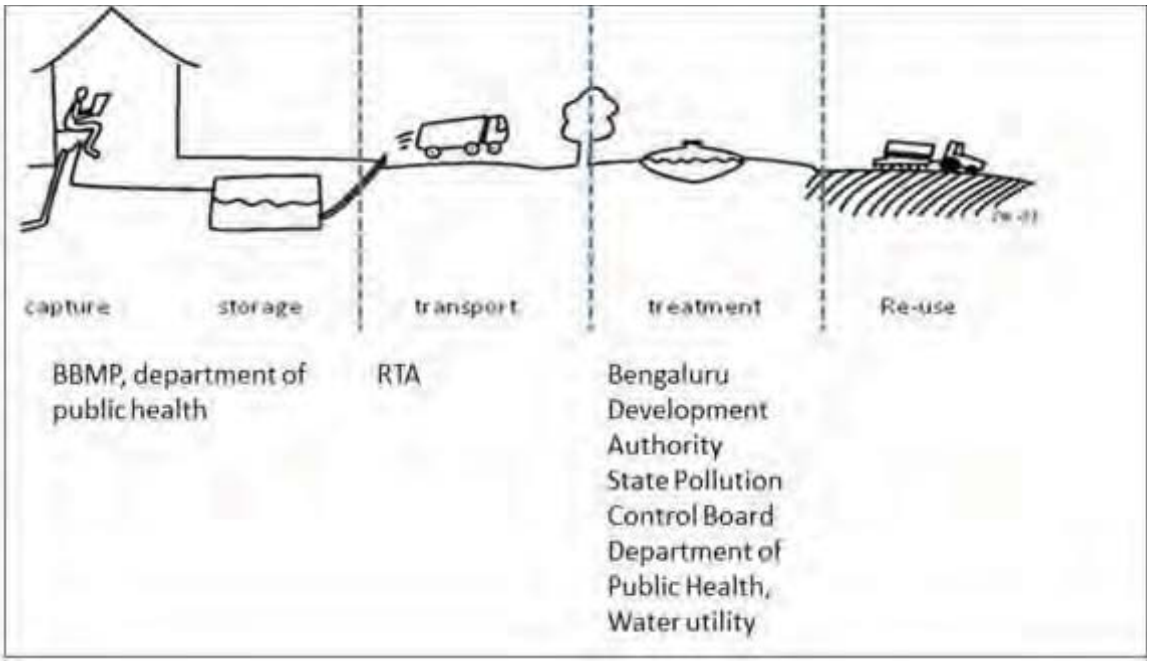

Figure 2 The urban sanitation chain in Bengaluru
Illustration by Jan Wijkmark.

A1.2.2.1 Household level sanitation

Bruhat Bengaluru Mahanagara Palike (BBMP Greater Bangalore Municipal Body), the administrative body responsible for the civic and infrastructural assets of the city of Bengaluru approves building construction plans and gives completion and occupancy certificates to buildings when completed. The BBMP insists that a toilet with certain minimum dimensions is shown on the plan of every new building, but does not require for any form of disposal to be indicated on the approved plan, or on the completion certificate. Nor has anybody, as far as is known, been penalised for the violation of building norms in relation to the presence or quality of sanitary facilities.

A number of years ago, the State Pollution Control Board (KSPCB) mandated that "sewage treatment plants are built and operated in individual residential complexes having fifty or more dwellings, or generating 50 m3/ day or more of sewage". Additional conditions imposed, among others, are that "the treated water quality shall meet stringent 'Urban Reuse Standards' and that treated water shall be reused for toilet flushing (thus requiring dual plumbing system in the residential complexes) for car washing, and for irrigation use within the campus"(Kodavasal 2011, p.13). In 2011, a number of apartment complexes received notifications from the KPCB for not meeting the required standards for the released water. However, inspections are rare and these regulations are not enforced regularly and in a systematic manner (CSE, 2011; Citizens Matter, 2011 and Baken, 2008).

The 1983 National Building Code of India describes the design of septic tanks and states that these need to be emptied at least once a year. However, in practice local government lacks the capacity to enforce these rules (AECOM/ SANDEC, 2010). The KSPCB is responsible for defining standards for the release of wastewater, but it does not monitor domestic waste coming from households, nor does it insist on any specific form of sewage disposal for households (CSE, 2011).

A1.2.2.2 Transport of sewerage

The *Bengaluru Urban Development Authority* (BUDA) is responsible for preparing the Comprehensive Development Plan which sets out the anticipated population growth, the expected density of settlement, land-use and the water supply and sewerage infrastructure requirements. However, BUDA does not monitor, and is not responsible for, the quality of construction, the emptying and disposal of sludge from soak pits/ septic tanks or any other waste stream coming from the households.

The *Bangalore Water Supply and Sewerage Board* (BWSSB) is responsible for providing water supply and sewage facilities within the Metropolitan Area. BWSSB has to plan, design, implement and manage the entire sewerage system for the city's metropolitan area. The Board falls within the jurisdiction of the Bengaluru Municipal Corporation. Only in places served by sewerage does the utility insist that the households disconnect from soak pits and connect to the sewage lines.

In practice, the BWSSB does not monitor nor insist on any form of sewage disposal or treatment in areas that are not being served by a sewerage network[13]. It is not monitoring the actual disposal of waste from households at all. Neither does the BBMP register or monitor the activities of the honey-suckers nor do they monitor or insist upon particular forms and places of disposal, such as on private agricultural land, sewage treatment plants or even landfills.

The Regional Transport Authority (RTA) is responsible for registering and giving fitness certificates to vehicles on the road, including the tankers of the honey-suckers.

A1.2.2.3 Treatment of sewage

The Environmental Protection Act (EPA) explicitly prohibits discharge of pollutants in excess of prescribed standards. However, the Centre of Science and Environment (CSE) states that nearly 80% of the water pollution in India is caused by discharge of untreated domestic wastewater from urban centres, responsibility for which often lies with the government-supported Public Health Engineering Departments (PHEDs) and ULBs. Due to lack of technical, managerial and financial capacities these agencies are not able to carry out their duties (CSE 2011, p.35).

[13] Source: personal communication with BWSSB officials and other key informants.

In Bengaluru, the BWSSB is responsible for the treatment of sewage. The Karnataka State Pollution Control Board (KSPCB) is responsible for defining the standards for the release of wastewater. The KSPCB does not systematically monitor domestic waste coming from households nor does it insist on any specific form of sewage disposal for households that are not part of large complexes[14]. In addition, as far as is known, the KSPCB does not concern itself with nor monitor the honey-suckers for the contents of the vehicles, the places from where they obtain their contents, nor the places where the contents are disposed.

The BWSSB is also responsible for the treatment facilities within the Metropolitan Area. Only in areas that are covered by the sewerage network does the BWSSB insist that households disconnect from soak pits and connect to the sewage lines. In practice, the BWSSB does not monitor or enforce treatment of sewage in those areas that are not covered by the sewerage network. Recently, the BWSSB has brought in a system whereby the honey-suckers can dispose of their contents in designated sewage treatment plants, based on a protocol that is yet to be developed. However, as argued above, the BWSSB does not monitor or enforce the use of these facilities. The vacuum trucks are charged a fee of INR 20 (€ 0.30) per kilo-litre of sludge deposited in the sewage treatment plants. There is no separate policy for disposal of faecal sludge from the sewage treatment plants themselves. The sludge is normally sold or auctioned for disposal.

[14] KSCPB defines large complexes as those with more than 50 households or those producing more than 50 cubic metres of waste water.

Annex 2 Summary responses of tanker operator customers

Answers of customers semi-structured interviews (No. of informants: 11)

Question	Summary of answers
How was the tanker operator approached?	Social network: 8
	Formal channels: 3
Does the customer work with the same tanker operator, or does s/ he search for one randomly?	Randomly: 4
	Same: 1
	No answer: 6
What is the price paid for the services per tanker (in INR)?	1400-: 2
	1100-1300: 3
	900-1000: 2
	700-800: 3
	<500: 1
Is the customer satisfied with the services provided by tanker operators?	Yes: 11
	No: 0
Is there awareness on where the contents of the tanker are being taken? If 'yes', in which locality are the contents dumped. How far is would this be from the customer's home?	Yes: 4 – to farms and in one case either farm or empty plot. Distance to farm: varying between 2-6 km from their homes/ premises
	No: 7
Would it concern the customer if the contents of these tankers are dumped somewhere near or within the city's boundaries?	Yes: 9. Concerns range from stagnant water, water pollution, and if the sludge would be dumped close to their own plots. One mentioned that it would be positive if it was used for farming.
	No: 1
	Had not thought about it: 1
Is the customer willing to pay 50% extra fees to make sure that the sludge is disposed of in a safe place (why or why not)?	Yes: 7 (4 said they did not know what the safe option would be)
	No: 4 (2 mentioned that this safe disposal should be part of the fee paid to tanker operator already)
Are you aware where the sullage in the city is taken?	Yes: 2 No: 9

Annex 3 Summary responses of tanker operators

Summary responses tanker operators (No. of informants: 5; 4 owners and 1 driver)

	Question	Summary of answers
General Information	Why get into the honey-sucking business?	Four of five (all tanker owners) mentioned good money in the business
	What is the size of the business?	1 truck: 3 3 trucks: 1 8 trucks: 1
	Are taxes being paid?	Two of the five tank owners pay taxes
CVP	What does the job entail (activities)?	Removal of (i) faecal sludge from pits, (ii) effluent from decentralised, residential sewage treatment plants, (iii) effluent from software industries.
	Does the service provided fulfil customer needs?	Clean-up of septic tanks and removal of sewage.
Revenues	Are emptying services being charged? How much?	The charge varies between INR 800-3000 per emptying service. The one person with a real quality offer at hand is also the one charging the most, having a happy driver who has stayed with his employer for a long time.
	How much is paid by the farmer when emptying on farmland?	INR 0: 4 (owners of the tanker truck) INR 100 per load: 1 (the driver interviewed, unclear if every load generated INR 100 or not)
	Any seasonal fluctuations?	No seasonal fluctuations: 2 Higher demand during monsoon: 3
	How many customers are served per day?	Three to four customers per day, and between six to eight customers per day during the monsoon, according to one operator
FS going to farms	What is the percentage of FS going to farms?	100%: 2 20%: 1 10%: 2
	What are the reasons behind emptying FS on farms?	Saving fuel was mentioned as a reason by one operator. The only known way to deal with the FS is mentioned by another operator who empties 100% on farms, claiming that it is useful to farmers. According to the driver respondent, FS emptying on farmland generates extra income – he too empties 100% of FS collected on farmlands
Costs	How much is spent for capital costs, office space, and equipment?	None of the interviewees were found to have offices. The costs of trucks vary between INR 400000 (used) to INR 1700000 (new).
	Permits, licenses, insurances?	No permit: 1 Permit[15]: 4 Insurance: 1

[15] Different types of permits were mentioned by the study's informants, including a permit to lift sewage from the Karnataka Pollution Control Board, a permit from the BWSSB, a permit from the Regional Transport Office (RTO), and an unidentified, second-hand permit. It is interesting to note that the tanker operator with a 'second-hand' permit is paying to the original holder per month, while another tanker operator is paying every five years for a permit from the KSPCB.

	Fuel costs per month per vehicle?	INR 12000 - 30000
	Yearly maintenance costs?	INR 10000 - 75000
	Salaries?	Varies between INR 3000 – INR 15000 per month, with wide variations across owners. Drivers were reported to receive a higher salary than the helpers. The largest player pays the highest salaries. The lowest paid workers receive INR 125 per day.
	Overhead costs?	One mentioned the interest rate on a loan on the tanker truck and another, the monthly costs for the second-hand permit.
	Costs of legal disposal of sludge?	INR 8 – 12/ 1000 L. Only two operators mentioned legal disposal costs.
Institutional relationships	Any formal relationships with institutions?	Has no formal relationships: 2 Has formal relationships: 3 Institutions/ formal relationships mentioned: BWSSB, KSPCB, ELCIA, financer for loan on truck.
	Legally, where is the FS supposed to be emptied?	Do not know: 2 At treatment plants: 3
	How is the legal framework enforced?	Not enforced: 2 Enforcement of carrying license for emptying and transporting sludge: 3
	Why are certain parts of the framework not enforced?	Not aware: 2 Impossible to enforce where the FS is emptied: 3
	Any sanctions feared?	None: 4 Strict regulation to control emptying in storm-water drains: 1
	Weak links in institutional setup/ legal framework	NA: 3 Less distance between treatment plants where FS can be emptied legally: 2
	Problems with authorities?	Yes: 1 (unwilling to talk about what kind of problem) No: 4
	Bribes?	Yes, INR 150 each time police stops tanker truck: 2 No: 3
	What are the effects of working with a non-enforced legal framework?	Clogging of drains: 1 None: 2 Potential ground water pollution: 2
	Any problems encountered when emptying?	None: 3 Smell, subsides in 1-4 hrs.: 2
Relationship with farmers	Who initiates reuse?	Tanker operator: 3 Farmer: 1 Both: 2
	Are payment for FS received from farmers?	No: 4 Yes: 1
	Are the same farmer(s) visited all the time?	Yes: 5 No: 0
	Any more farmers interested?	Lack of farmers in the vicinity: 2

Societal attitude and relationship with employees	What is the attitude towards FS reuse?	Accepted: 5 Not accepted: 0
	Any difference in acceptance across different layers in society?	More accepted at farmer level, less accepted at decision-making/ authority level: 5
	How is the relationship with employees?	High turnover of employees, poor relationship: 3 Good relationship, low turnover: 2

Annex 4 Summary responses of farmers

Summary semi-structured interviews farmers (No. of informants = 5)

	Farmer 1				Farmer 2		Farmer 3	Farmer 4	Farmer 5
Crop	Coconut	Sapota (Chickoo)	Arecanut	Rice, Tomatoes, Ragi	Tomato, Mexican grass, Ragi, Rice	Banana	Beans, Lady finger, Finger Milles, Sorghum	Ragi	Flower, Potato, Vegetables, Ragi, Sorghum, Cattle Fodder
Traditional fertiliser									
Material	60,000	20,000	700,000	24,000	50,000		No response farmer	30,000	75,000
Labour				9,600	-			1,000	-
Faecal Sludge									
Material costs	-	-	-	12,000	-			3,500	30,000
Labour costs	-	-	-	4,800			NA	1,000	NA
Cost saving (INR)	**60,000**	**20,000**	**70,000**	**16,800**	**50,000**		**8,000**	**26,500**	**45,000**

Summary farmers responses (N = 4)

Clients of agricultural produce	Findings
Discuss issues such as: the main buyers (wholesalers or retailers), their reaction to the use of faecal sludge, and do they have regular or casual clients?	Four out of five farmers mainly sell to wholesalers. For the farmer Ramakrishnappa, this is not clear as he does not know what kind of market the Agricultural Sales Yard is.
Tanker operators	
Discuss issues such as: how do they get in touch with their customers, how often do they visit, are the same tanker operators coming again and again, do they get paid?	There is no formal marketing strategy. In two cases, farmers were approached by tanker operators, and in two other cases farmers were invited. The fifth farmer (Ramakrishnappa) appears to be a bit of an exception.
Relationships with other farmers who receive faecal sludge	
Why do farmers buy faecal sludge, does the tanker operator advise farmers how to use FS, why are other farmers not buying the sludge?	Only one farmer sells sludge to other farmers.
Authorities	
Is the farmer ever in contact with authorities regarding the use of faecal sludge, have problems been encountered with the authorities, is the farmer in contact with service extension officers – if yes do the service extension officers provide useful support?	Only one farmer (the one who lives near the city and is selling FS to other farmers) has encountered problems with other farmers.
Neighbours	
Do the farmer's neighbours know that faecal sludge is being used, have there been any problems?	Only one farmer was reported to have problems with his neighbours. Other farmers do not experience problems with their neighbours - this is likely to be related to his proximity to the city.
Farm labourers	
How do the farm labourers feel about working with faecal sludge, how do they take the sludge out of the pit, how is it taken out and transported to other farmers, do they wear protective gear such as gloves and boots?	Based on interviews, wet sludge was found to be more of a problem compared to dry sludge (which seems safer). However it must be noted here that interviewing directly farm labourers may result in answers different to the farmer owner himself/ herself.
Infrastructure for reuse?	Essentially, farmers use two technologies: • Dig a pit and leave the sludge to dry. • Directly apply the wet sludge on the crops. Some considerations: • What does this mean in terms of safety, especially in relation to the different types of crops? • How important is the water in the wet sludge or is it only about nutrients?

Description and size?	The average volume of the tanks is 14,536 litres; however, it is not known how often they are emptied, and what would be the volume of remaining solids once the water has evaporated/ leached away.
Method of applying sludge?	There are different ways of using the sludge: • Collecting it in a pit and allowing it to dry before spreading sludge to the fields. • Spreading it on empty fields and allowing sludge to dry before ploughing it into the ground. • Distributing the wet sludge through channels (e.g., banana plantations).
Adverse effects from using sludge?	Only two farmers mentioned experiencing negative effects linked to the use of sludge (increased water use).
Increased yield?	Four out of five famers mentioned that their yields have increased as a result of the use of '*humanure'*. The fifth farmer mentioned that '*humanure'* is more effective that the farm manure normally used.
How much sludge is dumped on the farmer's land in one year?	No clear data on the number of truck loads. The differences between the two farmers who have provided data are very large.
How much of the sludge is used for the farmer's land?	
Is the sludge sold to other farmers? How many farmers would buy?	Only one out of five famers sells the "*humanure"*.
Institutional, consumer and perceptions	
How did the farmer start using faecal sludge?	All answers provided by the farmers show that from their perspective, there had been no barriers to reusing human waste. Three out of five farmers mentioned that this is an old existing practice.
Any changes in taste, yield or quantity – either positive or negative?	Only positive effects were mentioned.
What kind of negative consumer reactions have been encountered?	All five mentioned that no negative consumer reactions were encountered.
Any negative reactions encountered from the wholesaler?	All five mentioned that no negative reactions from wholesalers were encountered.
Any positive reactions encountered from the wholesaler?	Four out of five farmers mentioned that they did not get positive reactions from wholesalers.
Worker reactions?	Three out of five farmers mentioned that there have been no problems encountered; however, this study did not go as far as to interview the labourers themselves.

What does the farmer know about the laws surrounding the use of faecal sludge?	All famers were not aware of the legal framework.
Any conflict with the community? What type of conflicts is there? On what grounds?	Four out of five farmers mentioned no problems, but they all seem to be situated in fairly remote locations.
Any conflict with authorities? What type of conflicts would this be? On what grounds?	One out of five farmers has a conflict with the authorities, as well as problems with the community. The farmer experiencing problems reported to be living close to the city.

Annex 5 Data collection tools

Farmers

Transect walk on farm

Introduction[16]

A transect walk is a walk cross-cutting the community to capture the greatest diversity of land-use and eco-systems. Doing a transect walk is a way to ensure that the research area is explored to the full and is often used in projects related to forestry and agriculture. It can help identify types of crops, presence of irrigation systems, and total size of the farmed land. Moreover, the transect walk is an excellent opportunity to establish a good rapport with the farmer.

Procedure

- Get together with the people involved in the walk, in most cases the local team members and some general community members.
- Explain the purpose of the exercise – have a look at the total farmed area, types of crops, infrastructure and in particular the storage tanks.
- Select a logical starting point for the transect walk, which might be the highest point in the study area or the boundary, and divide tasks related to note taking and drawing.
- Start walking, observe and take time for informal, open-ended interviews with people living in the area. Allow the farmer to add whatever s/ he feels is important to mention at that very moment.

Data to be collected

- Size of land
- Types of crops
- Infrastructure for reuse
- Other infrastructure, equipment, quality of crops

Data sheet

Size of land	
Types of crops (including area or #)	
Infrastructure for reuse of human waste	
Other infrastructure	

[16] Source: Keep It Working A field manual to support community management of rural water supplies by Eveline Bolt and Catarina Fonseca IRC Technical Paper Series 36.

Seasonal calendar to understand the agricultural season

Introduction

Seasonal calendars can be developed for any issue on which seasonal variations might have an impact, such as people's time spent on agricultural activities, accessibility of a community, the discharge of a water source and prevalence of diarrhoeal diseases. This type of information helps to make realistic plans. It is no use planning a series of meetings during harvest season or planning construction activities for system extension during the rainy season. Seasonal calendars are created on the basis of interviews and group discussions. Visualisation, by using sticks of various lengths or seeds, helps to get a clear picture. This exercise builds on the previous exercise (the transect walk) that is used to collect data on the different types of crops being grown by the farmer. Make sure that all crops are included in this seasonal calendar.

Objective

To gain insight into agricultural seasons and in-seasonal variations for the use of manure.

Procedure and materials needed

- Explain the purpose of the exercise and ask the farmer about the time cycle they would like to use. This could be from the time crops are planted till the season where soils are prepared for the next planting season, or the government fiscal year.
- Draw the time cycle on the ground or on a piece of paper and ask the farmer to indicate their way of sub-dividing it into shorter periods.
- After having visualised the cycle ask the farmer to indicate, for example, which crops are planted and harvested during each time period.

Semi-structured interview

For a semi-structured interview, keep a few key questions in mind, leaving you with the flexibility to go further into side issues, while at the same time preventing the interview from going off-tangent. A semi-structured interview has advantages over a completely structured interview; the latter only addressing issues from the perspective of the interviewer. Semi-structured interviews help bring to the fore the knowledge of farmers into research findings, at the same time exploring new issues and ideas. Such interviews build upon the data set collected during earlier data collection exercises. As a tool, semi-structured interviews have the advantage of giving farmers the feeling that their knowledge and ideas are valued and used.

Procedure and materials needed

- Develop a checklist with a few major questions only. Two basic types of questions can be distinguished: descriptive questions (formulated with what, when, where, by whom) and analytical questions (formulated with why and how).
- Get together with the interviewee(s) and look for a quiet place (Interviewees may also comprise of knowledgeable people from outside the community).

- Explain why s/ he or they were invited for an interview. Make clear that answers may go beyond the questions asked and that many questions will be formulated in the course of the interview, depending on what comes up.
- Carry out the interview and make brief notes for future reference.
- Wrap up the interview by thanking the interviewees and by asking whether they may be approached once again should the need arise.

Main issues to be covered in the (semi-)structured interview

Investment costs

- Capital costs for storage
- If any costs, how were these finance this (own resources, loan, else)

Additional operational costs for use of human waste

- Costs of growing the crops (salaries, equipment) – Additional costs due to sludge use? (labour, protection)
- Maintenance
- Overheads
- Other additional costs

Cost savings

- Crop 1 – costs of traditional fertiliser (this could be per tree per annum, per acre of crop per annum, etc.)
- Crop 1 – costs of reuse human waste (excluding investment in hardware or labour)
- Crop 2 – costs of traditional fertiliser (this could be per tree per annum, per acre of crop per annum, etc.)
- Crop 2 – costs of reuse human waste (excluding investment in hardware or labour)
- Difference in revenues of crops with traditional fertiliser and human waste, etc.

Revenue sales of human waste to other farmers

- Revenue sales of human fertiliser to other farmers (unit price and number of units sold in the last month)
- Seasonal fluctuations in revenue

Perceptions

- How did s/ he get around using faecal sludge?
- For farmers not using the faecal sludge: Why is s/ he not using it?
- Perception of health risks (labourers and consumers)
- Use of protective measures

Institutional and consumer issues

- Consumer reactions
- Worker reactions
- Awareness of legal framework

Venn diagram

People often do not realise how many (in-) formal institutions exist. Visually mapping out institutions, their importance and their inter-relations will reveal the roles and responsibilities of the various institutions.

Each circle represents an individual or institution, and the size of the circle indicates importance. Overlap occurs if one institution or individual asks or tells another to do something or if they have to co-operate in some way.

Objective

The Venn diagram helps the community members get an overview of the institutions within and around their community, their relationships and their decision-making and operational responsibilities.

Procedure and materials needed

- Ask the farmer to mention any formal and informal groups/ institutions in and around their farming operations.
- Ask people to identify what these groups/ institutions do and their respective roles.
- Draw circles of different sizes and label them with the name of the persons or institutions identified. People's information about the importance of the groups/ institutions should indicate the size the circles should be.
- Ask the farmer to arrange the circles in such a way that the stakeholders with whom they have a strong relationship are closet.
- Ask the farmer to describe the different relationships.

Issues to be covered

The following stakeholders and issues are expected to surface in the Venn diagram:

- Retail clients and wholesalers (including marketing), as well as their vulnerability towards consumer reactions
- Tanker entrepreneurs (how did they get in touch, frequency of visits, fixed relationship, payments)
- Relationship with other farmers
- Relationship with authorities such as EPA
- Relationship with neighbours

Customers of tanker operators

Semi-structured interview

See description of semi-structured interview method and procedure and materials needed on pages 53-54.

Main issues to be covered in the (semi-)structured interview

Background information

- Name and address of interviewee
- Type of house: (material used for building, no. of floors, no. of rooms)
    - Type of house: individual house = 1; multiple apartment = 2; institute (hotel, office, hospital = 3).
- Number of people in the household including servants. In the case of an apartment or office this number can be interpreted appropriately
    - Number of people

Sanitation type and construction

- Sanitation system in place:
    - Type of sanitation system (sewerage connection, septic tank, holding tank, soak pit)
    - "Soak pit = 1
    - Septic tank = 2
    - STP = 3"
- Technical details: size, material being used, are the wall plastered, is the bottom permeable?
- Construction: why was the final option selected (who advised, what arguments), who constructed the septic tank/ holding tank/ soak pit?
- Construction: how much were the construction costs (cost + year of construction)?

Sanitation maintenance and emptying

- Was maintenance or repair undertaken? If yes, register the type of maintenance, costs, and year of maintenance
- How much were the maintenance costs (monthly)?
- What is draining into the septic tank/ holding tank/ soak pit; toilet (if yes how many); shower; washing machine; kitchen sink; other..."?
- How is the tanker operator identified? Does the interviewee work with the same tanker operator, or is the selection process done at random?
- What are the costs of operation (costs + year of last emptying and frequency of emptying)
- Costs per tanker, how much?
- Is the interviewee satisfied with the services and the price provided by the tanker operator?

Environment

- Is there awareness on where the contents of the tanker are taken? If “yes” have the interviewee indicate the locality where the contents are dumped. How far would this be from the interviewee’s home?
- Is it a concern for the interviewee if the contents of tankers are dumped near or within the city’s boundaries?
- Is the interviewee willing to pay 50% extra in fees to make sure that the sludge is disposed of in a safe place (why or why not)?
- Is there awareness on where the sewage in the city is taken?

Tanker operators

Semi-structured interview

See description of semi-structured interview method and procedure and materials needed on pages 53-54.

Main issues to be covered in the (semi-)structured interview

Background information

- Name of tanker operator
- Date of visit
- Area
- Name of interviewer
- Start by asking how that tank operator got into this business. What was the motivation for starting the business and what are the motivations for staying in it? These questions can also act as ice breakers. At a later point, one may ask the question, what is seen as the future of the business?

Customer value proposition

- What job needs to be done?
- Does the service offered fulfil customer needs?
- Revenue?
- How much does the tank operator get paid at the time of emptying, and what is the basis of these charges?
- Any seasonal fluctuations (more emptying in monsoon season)?
- How many customers does the tank operator have every week during the peak season and the low season? Do the charges also vary according to the season?
- What ratio of the loads finds its way to farmers? What happens to the remaining sludge?
- How often does the tanker operator dump his/ her load onto a farmer? What are the advantages of doing so (is the tank operator paid to do that, does the tank operator save on fuel or time, anything more)?

Cost structure: fixed costs

- Capital costs for truck, equipment and office space?
- Official price of permits and licenses? Any insurance costs?

Cost structure: variable costs

- How much is spent on fuel every week?
- How much is spent on maintenance of the tanker every three months? How many years can a tanker last?
- How much is spent on salaries? Are there variations over the year?
- Overheads?
- Cost of legal disposal of sludge?

Market ownership

- Which areas are serviced by the tanker operator? Is there a conscious effort to stick to one geographical area? Why?
- Is the market operated on an individual basis or through some kind of collective approach?
- How are customers found?
- Does the tanker operator have fixed customers, or are there variations linked to a business organised based on an on-call approach?

Market typology

- Competitive, cartel, mix, monopoly?
- Does the tanker operator communicate with other tanker operators? How is it possible that all tanker operators are charging the same price? Do they fix prices through, for example, an association of tanker operators?
- Does the tanker operator compete with other tanker operators or do they all have their designated areas? What is the tanker operator's source of market information, regarding other tanker operators?

Market organisation

- Does one person own many tankers, does one person own one tanker and hire a driver, does one person own and drive the tanker itself, and/ or are there tanker associations?

Relationships and institutions

- Ask the entrepreneur to mention any formal and informal groups/ institutions in and around their operations.
- Ask the entrepreneur to identify what these groups/ institutions do (their respective roles).
- The idea of reuse: did it come from the tanker operator or from the farmer?
- Do farmers get paid for their truck loads, or do the tanker operators pay the farmers? Would they go back to the same farmer every time?
- Are more farmers interested? Are they lacking farmers? How do they communicate with each other (tanker operators and farmers)?
- Any competition over the dumping grounds and/ or available farmers?
- Are there problems encountered with authorities? If yes, what are these problems?
- Legally speaking, where could the sludge go?
- How is the entrepreneur's relationship with his/ her employees? How long do employees stay in the company? How are employees hired?
- How is the legal framework enforced? Which parts are enforced and which are not enforced?
- Why are certain parts of the legal framework not enforced?
- What sanctions does the tanker operator fear?
- Which are the weak links in the legal and formal institutional framework, according to the tanker operator?
- What are the effects of the non-enforced legal framework (e.g., pollution of ground-water etc.)?
- What is the general attitude towards faecal sludge reuse in society?

- Which groups in society support the faecal reuse that tanker operators are helping with?
- Is there a difference in attitude towards faecal sludge reuse between different social strata (e.g., is reuse more accepted at farmers' levels rather than at decision-making level)?
- Semi-structured interview II – for the drivers.
- Any problems encountered with authorities (illegal dumping, bribes)?
- Any problems encountered at the dumping sites (location of dumping sites?
- Relationship with the owner of the tanker (if applicable).

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