SECTION III – NUTRIENT AND ORGANIC MATTER RECOVERY

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Photo: IWMI

Nutrient and organic matter recovery: An overview of presented business cases and models

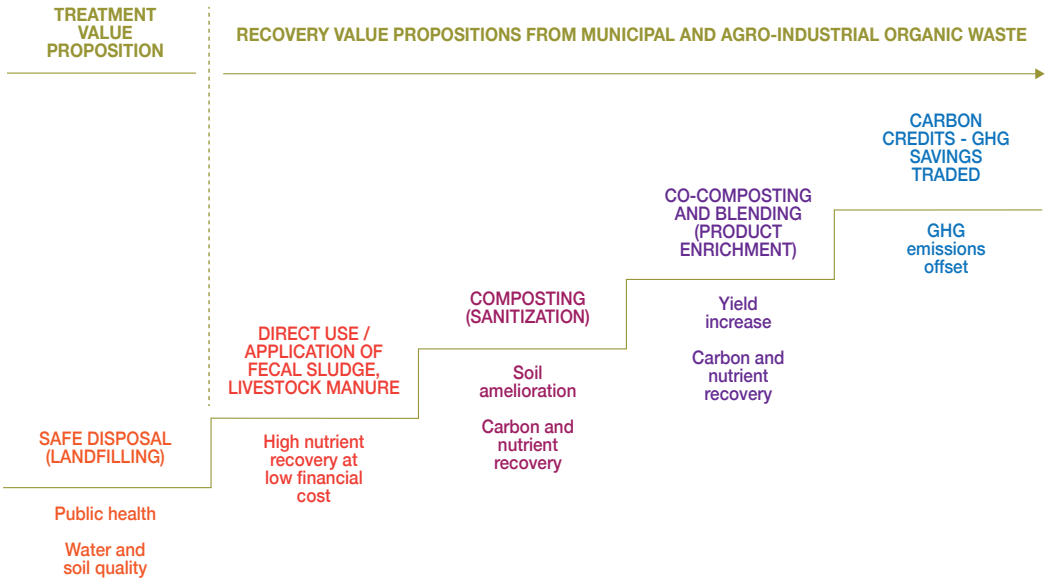
Nutrient recovery from organic waste streams such as municipal solid waste, agro-industrial waste, urine and fecal sludge, is high on the development agenda. The increased momentum around nutrient recovery is largely driven by the need to feed the global population with increasingly limited resources under progressing climate change, diminishing global nutrient reserves (peak phosphorus), increasing fertilizer prices and stricter regulations for safeguarding the environment from pollution. In this context, increasing amounts of plant nutrients will be needed to ensure the food security of an expanding global population. However, while a century ago, food waste was locally recycled, urbanization has created a polarizing effect on food flows, thus generating centres of consumption and waste generation. Nutrient recycling is therefore crucial in preventing cities from becoming vast nutrient sinks (Drechsel et al., 2015; Otoo et al., 2012; Otoo et al., 2015). Unfortunately, in most low- and middle-income countries, urban waste management continues to struggle with waste collection and safe disposal making e.g. nutrient recovery only a future target. However, simultaneous efforts are required and possible, also as the waste and sanitation sectors are under pressure to cut costs and show cost recovery. The waste volume reduction through composting and agricultural demand open related opportunities (Drechsel et al., 2015).

Nutrient recovery is additionally of great importance in view of diminishing non-renewable resources, such as phosphorus. As large portions of global phosphate rock deposits cannot be mined efficiently at competitive costs, there is a great debate on when the world will reach a state of 'peak phosphorus' and how far market prices will regulate phosphorus supply (Edixhoven et al., 2013). On the other hand, there is a consensus that the recovery of phosphorus is an increasingly important task, especially given that soils in many tropical developing countries are of very low fertility and fertilizers too expensive. The latter is evident in many African countries and attributed to ineffective policies, and limited and inefficient distribution network. This results in exorbitant market prices, and invariably leading to low fertilizer application rates and decreased agricultural productivity.

Furthermore, nutrient recovery from organic waste streams such as agricultural and agro-industrial waste, the biodegradable fraction of household and market waste, domestic urine and fecal sludge, extends beyond direct economic benefits to health and environmental benefits (ADB, 2011; Hernando-Sanchez et al., 2015; Otoo et al., 2015; Rao et al., 2016). With increasing population growth, nutrients accumulate in consumption centres and contribute to pollution wherever the coverage of waste collection and treatment is insufficient. With progressively limited public funds to support waste management infrastructure and services, particularly in large urban areas in developing countries, nutrient recovery enterprises will be essential for reducing waste quantities and generating revenues from recovered resources to bridge financial gaps (operational and maintenance [O&M] costs) and complement other supportive financing mechanisms for waste management.

There is great potential to close the nutrient recycling loop, support a 'circular economy' and attain cost recovery within the waste sector, and even to create viable businesses. While, many of these efforts have often been limited in size or duration partly because waste is not viewed as a resource and sanitation is a public service rather than a business; there are many interesting and successful examples of cases and business models emerging in developing countries. These cover a wide range of opportunities for waste valorization (Figure 117) and demonstrate significant potential for scalability and sustainability.

FIGURE 117. LADDER OF VALUE PROPOSITIONS FOR NUTRIENT AND CARBON RECOVERY FROM EXCRETA, AGRO-INDUSTRIAL/AGRO-WASTE AND MUNICIPAL SOLID WASTE STREAMS



Significant investments, mainly public funding, for the set-up and operation of compost facilities is observed throughout the developing world (Kaza et al., 2016). These compost plants are typically large-scale centralized facilities that are able to process huge volumes of waste at a time, but require substantial capital investments, and operational and maintenance costs given the advanced and mechanized equipments used, high-level skill and high energy requirements. Although geared towards full cost-recovery, many of these initiatives are unable to generate sufficient revenues to cover the O&M costs, talk less of recouping capital investments. Municipalities however continue to provide financial support in the form of government grants, subsidies, tax credits, waivers and rebates to bridge the financial gap and ensure sustainability of the compost plants (Kaza et al., 2016; Pandyaswargo and Premakumara, 2014). This is because the net environmental and socio-economic benefits from composting (typically municipal solid waste (MSW) and fecal sludge) outweigh the costs of financial support to the compost plants (**Business model 10: Partially subsidized composting at district level)**. In this nutrient recovery section of this Resource Recovery and Reuse (RRR) catalogue, we present three such cases from **Sri Lanka** and **Uganda**, representing different waste streams and options of public-private partnerships.

In view of increasingly shrinking budget allocations for waste management, a notable percentage of compost plants reach the end of their life cycle or in dire need of upgrade and maintenance, especially to improve their production efficiencies and revenues. Decentralized composting enterprises offer some advantages over centralized large-scale systems and are increasingly observed to be financially self-sustaining, particularly for secondary cities and small towns, and even large cities where the local government can allocate land (**Business model 11: Subsidy-free community-based composting**). In instances where technological processes adopted capitalize on abundant local resources (e.g. labor), and models that attribute ownership to communities are encouraged (e.g. cooperatives), high sustainability of the nutrient recovery enterprise has been observed. The presented case study from

Kenya in Chapter 8 shows that subsidy-free community based composting offers a sustainable solution for turning waste into wealth but requires investments in social capital to organize and mobilize the communities.

Looking beyond cost recovery and aiming for profit-making models is imperative if sustainable financial returns on investments are expected (**Business model 12: Large-scale composting for revenue generation**). While the composting concept is applicable across scale, larger composting operations offer greater opportunities for capturing economies of scale benefits, revenue generation and market proliferation. Multiple revenue generation streams beyond compost sales to include sale of energy (electricity) represent additional avenues for nutrient recovery enterprises to become financially viable. The ability for businesses to successfully implement the above value propositions and capture the greatest economic benefits will partly depend on scale and strategic partnerships. The scale element of the model offers access into markets that smaller-scale enterprises are often excluded from such as the energy and carbon credit markets. Although, it is important to note that there are cases where small-scale enterprises form conglomerates to increase accessibility into these markets. The need for strategic partnerships extends beyond those with NGOs for development of waste-based clean development mechanisms (CDM) projects, compost marketers and dealers for increased market share to include municipal authorities for exclusive rights/access to waste streams, research institutes for product and technology innovation, informal workers for increased access to slums and waste segregation efficiency and private sector entities for mitigating fiscal constraints. Mainstreaming private sector participation via public-private partnerships (PPP) can improve production efficiencies and business effectiveness and ensure value for money of public interventions as demonstrated by presented cases from **India** and **Bangladesh** in Chapter 9**.** Development of high value products (e.g. nutrient-fortified compost tailored for specific crops and soils) based on innovative technologies to enhance competitive advantage in product markets often allow enterprises to mitigate market distortions, for example, in the fertilizer market.

While the first three business models largely centre on food waste and municipal solid waste stream, another set of interesting business models focuses on nutrient recovery from agro-industrial and agro-waste (vegetative and livestock) streams. To ensure business sustainability, largely for compliance with legislative mandates, many agro-processing enterprises are increasingly implementing an additional arm to their main business for converting their waste into organic fertilizers. Conversion of their waste into nutrients is imperative, particularly given that the implicit cost of non-compliance can be significant due to their large operational scale, resulting in potential losses of up to several million dollars in annual revenue (**Business model 13: Nutrient recovery from own agro-industrial waste**). Chapter 10 presents several variants of this model via empirical cases from **Kenya, India** and **Mexico.**

In addition to nutrient recovery from municipal solid waste and agro-industrial waste streams, another set of interesting business models considered in this section focus mainly on fecal sludge and urine reuse for agricultural production. Global mandates to improve access to sanitation (toilets facilities) at the household level in developing countries is notable although some groups such as migratory populations and slum inhabitants still only have marginal access to sanitation products and services. An increasing number of private businesses are setting up public toilet facilities to close this gap, however limited septage collection and treatment can undermine the sustainability of these services. Benefits from nutrient recovery from fecal sludge into value-added products (e.g. urine-enriched compost) for agricultural production are three-fold: a) it significantly reduces the burden for septage collection, treatment and disposal, ensuring a sustainable sanitation service chain; b) it provides sanitation businesses with an additional revenue stream; and c) it provides a sanitized and nutrient-rich compost product for farmers. The latter is an important driver for the business model as

farmers have a great demand for the nutrient-rich fecal sludge-based compost (often a substitute for chemical fertilizer) compared to the often low-nutrient MSW-based compost. Chapter 11 describes a case from **Rwanda** where private entities are capturing the commercial value in fecal sludge via nutrient recovery to ensure sustainable delivery of sanitation services (**Business model 14: Compost production for sustainable sanitation service delivery**). It is important to note that while reuse can ensure a sustainable sanitation chain, public toilet fees remain the key driver for financial sustainability of this business model. The case presented here only shows a medium-scale operation and links to the agricultural sector; for a more extensive review on fecal sludge reuse cases and models at different scales and recovered resources, see Rao et al., 2016.

Beyond the formal avenues of septage treatment via nutrient recovery, an interesting model observed in developing countries, is where cesspit truck operators deliver nutrient–rich septage collected from households to farmers' fields instead of designated or unofficial dumping sites – with the latter being more common (**Business model 15: Outsourcing fecal sludge treatment to the farm**). This model is largely driven by farmers' high demand for nutrient-rich septage, therefore bypassing a more formal sanitation process in the form of composting for direct disposal of raw fecal sludge on their farm fields. This practice is increasingly observed in Sub-Saharan Africa and South Asia (Cofie et al., 2009; Drechsel et al., 2011; Evans et al., 2013). The business model presented in Chapter 12, supported by a case from **India**, essentially relegates septage treatment to the farm and importantly reverses the cash flow as farmers pay the cesspit drivers for farm–gate delivery, whereas normally the transporter would have to pay a tipping fee for desludging into a treatment system. Disposal to farmlands outside the city offers a partial waste management solution, however better oversight and occupational and consumer risk reduction measures are critically needed. There are emerging models and cases that aim to increase the safety and usability of fecal sludge via composting, pelletization and blending of fecal sludge-based compost with rock-phosphate, urea/struvite or NPK, among others (see Rao et al., 2016).

Finally, there is also the potential for phosphorus (P) recovery from human excreta (**Business model 16: Phosphorus recovery from wastewater at scale**). The model presented in Chapter 13 demonstrates an opportunity for increased accessibility to phosphorus (in view of diminishing global P resources) for agricultural production and significant prospects for cost recovery if savings in treatment and sludge disposal costs are considered, as until recently phosphate recovery costs still result in prices higher than those of phosphate rock, unless niche markets are targeted. Although different technologies and approaches are possible for P recovery from human excreta, this chapter presents two cases representing the two ends of the opportunity spectrum. One is where urine is collected from unsewered households in **Burkina Faso** and sanitized in storage units for processing into liquid fertilizer (typically occurring at community-scale); and the other is based on phosphorus extraction from sewage treatment using the approach of Ostara in **Canada** as an example. The latter approach is applicable both at a community and large-scale level.

In summary, most of the examples presented in this section demonstrate the potential range of cost recovery to full profitability business models for entities considering nutrient recovery as an avenue for ensuring sustainable delivery of waste management services. Although not exhaustive, the presented cases and models show a tremendous potential for resource recovery and reuse, and private sector participation where the enabling environment is in place. Supportive institutional settings and regulations are important to support the businesses and control the well-known health and environmental risks appropriately, although these may not necessarily be sufficient in guaranteeing the viability of the enterprise (see Chapter 19). Particularly for nutrient recovery enterprises, access to finance, technology and consumers' acceptance will play an important role in facilitating or hindering their sustainability and scalability.

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7. BUSINESS MODELS ON PARTIALLY SUBSIDIZED COMPOSTING AT DISTRICT LEVEL

Introduction

Many municipalities in large urban areas in developing countries continue to face the challenge of waste management. Limited public funds to support waste management infrastructure and services has resulted in significant environmental pollution as the majority of the generated waste, whether collected or uncollected, is often disposed of untreated in open spaces, waterbodies and/or landfills (Drechsel et al., 2015; Kinobe et al., 2015; ADB, 2011). The long-term effects of these practices include increased human health risks from communities' exposure to untreated waste, and generation of significant quantities of greenhouse gas emissions in the form of methane. This situation is particularly exacerbated for cities characterized by a growing population and rapid urban migration (Sabiiti, 2011).

Policy makers are increasingly challenged to consider other viable options, including market-based approaches that can lead to achieving sustainable solid waste management for current and future generations. Emerging recommendations propose a 'circular economy' which builds on the concept of resource recovery and reuse (RRR), where municipal solid waste (MSW) recycling and reuse offer the opportunity to augment nutrient resources. Nutrient recovery from organic fraction of MSW through composting is increasingly been used as a solution to address the dual challenge of waste management and soil nutrient depletion in large urban areas of many developing countries.

Investments, mainly public funding, for the set-up and operation of compost facilities is growing throughout the developing world. These compost plants are typically publicly-owned, large-scale facilities processing significant quantities of waste at a time. The required operational and maintenance costs can be substantial given the advanced and mechanized equipment used, high-level skill required and high energy requirements. Whilst MSW composting has the potential to generate significant revenues from compost sales and recyclables and most compost plants are geared towards full cost-recovery, the revenues are often insufficient to cover the O&M costs, and less so capital investments. Municipalities are however incentivized to continue providing financial support to ensure the sustainability of the compost plants, as the cost of inaction or alternative existing options such as landfilling and incineration is greater than financial support for operating the compost plants (De Bertoldi et al., 1996; Drechsel et al., 2004; Hutton et al., 2009; EC, 2002). Although justifiable, these governmental instruments may disincentivize compost plants from achieving full cost-recovery given their continued dependence on external support.

On the other hand, although few in number, there are cases of publicly-funded compost plants which started out with the goal of partial cost-recovery but are on a path to financial independence. Key elements of their business strategy are: a) their ability to liaise with urban councils to enact waste tax for institutions that fail to segregate their waste (increased revenue); b) development of different formulations of compost tailored to different customer segments; c) compost product certification and branding; d) sale of carbon credits; e) production of fuel pellets and sale of non-degradable solids (recyclables); and f) improved operational efficiency of technologies. Additional success drivers include the set-up of satellite composting stations at vintage locations close to major customer segments, an avenue for reduction of transport and handling costs. Marketing strategies including free compost samples to first time users on a trial-and-pay basis, and special discounts on bulk purchases can incentivize compost use and upscaling.

While potential opportunities for 'business' in waste reuse are increasingly clear, scaling-up and sustainability of such entities often only emerge as a viable option when public and private actors work together. Case studies across South Asia indicate that while many composting plants hardly survive their pilot phase, successful ones leverage key strategic partnerships with different entities,

including community-based organizations and private entities to reduce risk associated with high capital investments, optimize the allocation of resources and activities and increase market access, thus increasing opportunities for profits. Innovative partnerships appear in most cases to have an important role to play where such businesses thrive (ADB, 2011).

In this chapter, we present the **Partially subsidized composting at district level** business model and supporting case examples, and the notable potential it offers for harnessing value from the organic fraction of municipal solid waste. Our examples are not exhaustive and better cases could have been inadvertently omitted due to information and time constraints, but they cover a moderate range of easily accessible cases in selected settings in Sri Lanka and Uganda.

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CASE

Municipal solid waste composting for cost recovery (Mbale Compost Plant, Uganda)

Charles B. Niwagaba, Miriam Otoo and Lesley Hope

Supporting case for Business Model 10	
Location:	Mbale, Uganda
Waste input type:	Municipal solid waste (MSW)
Value offer:	Provision of sustainable waste management services, provision of high quality compost, carbon credits
Organization type:	Government-owned public enterprise
Status of organization:	Operational since 2010
Scale of businesses:	Processes 60 tons of MSW per day
Major partners:	Government of Uganda, National Environment Management Authority (NEMA), Makerere University, National Agricultural Advisory Service, World Bank

Executive summary

Mbale municipal Composting Plant (MCP) is a not-for-profit entity which was started with the primary aim of reducing the quantity of solid waste landfilled and resulting greenhouse gas (GHG) emissions. Additional key drivers have been to: a) reduce open-dumping practices and maintain cleanliness of the city; b) provide an environmentally safe fertilizer alternative for farmers; and c) create jobs for local inhabitants. MCP uses a windrow composting technique and converts approximately 60 tons of waste that it receives daily into a safe organic fertilizer. This initiative is based on a **cost-recovery model** where it seeks to reduce waste management costs faced by the municipality. It mainly generates its revenue from sale of compost and recyclables such as plastics, and plans to engage in carbon trading in the near future as an additional revenue stream. Compost is sold primarily to farmers within Mbale, however MCP's compost product is gradually gaining popularity and is being sold in other regions. Plans are underway to reinvent its marketing strategy by advertising on national television to broaden its market scope. MCP did so far not break even and receives financial support from the government to partially cover its operational and maintenance costs. Additional subsidies are received as operational tax waivers from the National Environment Management Authority (NEMA). MCP has great potential to become financially self-sufficient. It however needs to improve the operational efficiency of its technology to reduce operational costs and invest in product innovation and branding to increase the market demand for its compost product. Additional revenue sources that remain untapped are waste collection fees to be charged to households and businesses. This will however require an instituted mandate by the municipality. Benefits from MCP's activities are substantial and include efficient waste collection systems which have reduced the quantity of openly-dumped waste and consequently

improved environmental and human health, and livelihood improvement for workers at the plant and farmers who now have access to affordable and safe fertilizer alternatives.

KEY PERFORMANCE INDICATORS (AS OF 2015)						
Land use	2.8 ha					
Capital investment:	USD 350,000					
Labor:	30 people					
O&M cost:	USD 13,400 per year					
Output:	4 tons of compost per day; 95% of incoming solid waste is fully degraded and recycled					
Potential social and/or enviornmental impact:	Provision of 21 full time jobs, reduced human exposure to untreated waste, improved environmental health from reduced GHG emissions, enhanced soil fertility and productivity					
Financial viability indicators:	Payback period:	10 years	Post-tax IRR:	N.A.	Gross margin:	N.A.

Context and background

MCP is a public project administered by the Mbale Municipal Council. Its main goal is to reduce GHG emissions and thus transform municipal organic solid waste into organic compost for agricultural use, thereby improving MSW management in urban areas. The project is part of a national program conducted by NEMA, under the Government of Uganda and World Bank-funded Environmental Management and Capacity Building Project II (EMCBP-II). MCP is located in Doko cell, Namataala industrial region, in the Mbale district. The present location of the site was previously (from 1950s) used as an official government landfill site. The revenue streams of the project are sales from compost and sale of recyclables such as plastics, whereas carbon credit is a planned main revenue, which is anticipated to generate an annual income of USD 25,000–USD 30,000.

Market environment

Most large-scale farming in Mbale is practiced on the slopes of Mt. Elgon, where soil fertility is lost through erosion. Chemical fertilizers and food and agro-waste (not composted) are the primary fertilizers used in restoring the soil nutrients. The nutrients in fresh/un-composted waste are not readily available to the crops. In addition, chemical fertilizers are expensive (approx. USD 1 per kg) and require regular applications throughout the plant growth stages. Mbale composting plant meets the need of the farmers by processing MSW to produce a comparably affordable organic fertilizer and with slow nutrient release into the soil thus requiring fewer fertilization re-applications. The opportunity that MCP exploits lies in the need for affordable and environmentally-friendly fertilizer alternatives by farmers and also sustainable waste management solution to reduce the quantity of landfilled MSW and direct human exposure to untreated waste.

Macro-economic environment

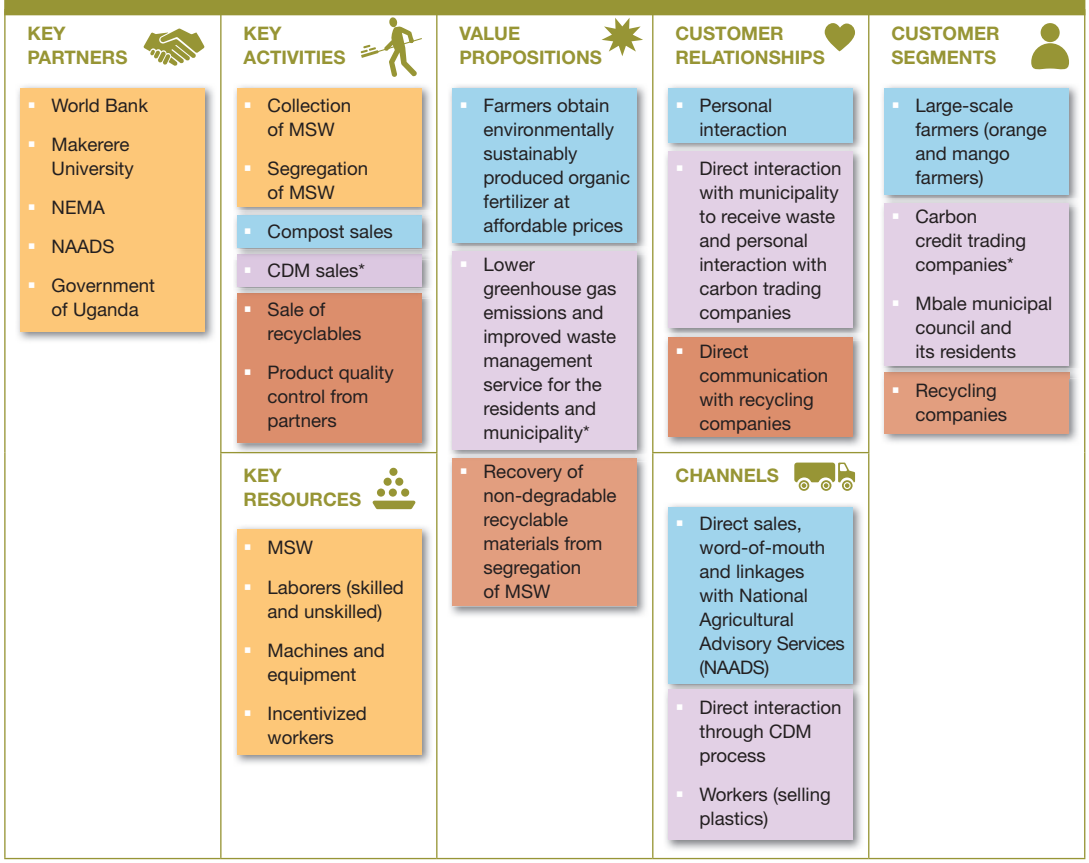
A market condition that could potentially impact MCP's business in Uganda is the price distortions in the fertilizer market from government subsidies for chemical fertilizers. The chemical fertilizer market in Uganda has however never expanded to a significant level due to the ineffective fertilizer policy. The limited use of chemical fertilizers in Uganda is striking and this has also been attributed to the lack of credit to farming households in Uganda. There is neither a large-scale government fertilizer program that provides subsidized fertilizer to farmers nor an active private fertilizer sector that supplies fertilizer at competitive prices (Yamano and Arai, 2010). Additionally, Uganda is landlocked, and with poor transportation system connections to ports, access to the external fertilizer markets is virtually

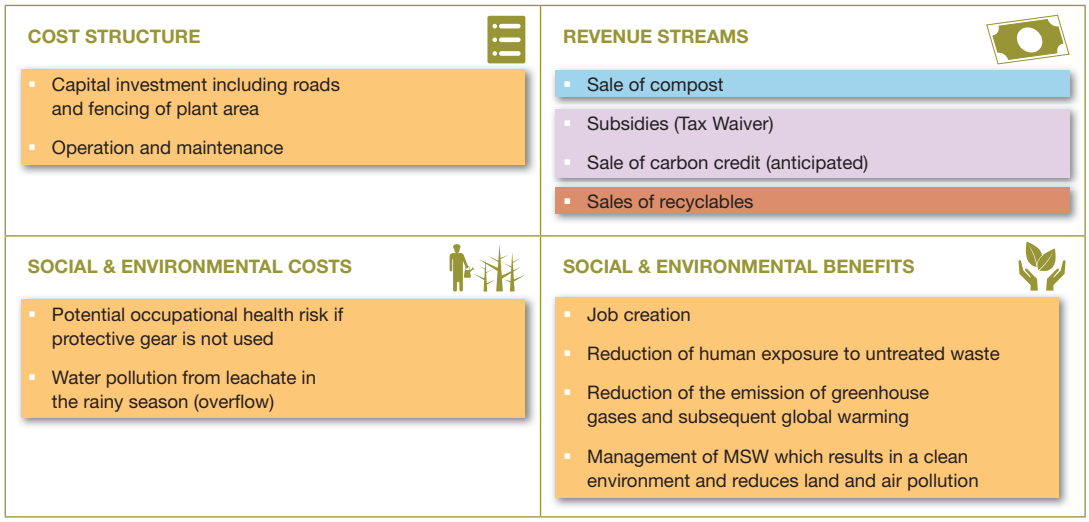
impossible in the country. This represents a great opportunity for waste-based organic fertilizer businesses like MCP who can take advantage of erratic chemical fertilizer prices and the limited number of actors in the respective market.

Business model

Figure 118 presents an overview of MCP's business model. MCP is a socially oriented public entity with the goal to reduce GHG emissions via the conversion of MSW to compost with resulting benefits of a cleaner city and improved agricultural productivity. Initial capital for setting up MCP was received from the central government and the World Bank. It partners with Makerere University and the NEMA for technical support. In implementing its objective, MCP receives and sorts MSW into degradable and non-degradable waste, of which the plastic non-degradable is sold to plastic companies by their workers. Allowing the workers to sell the recyclable waste to recycling companies and earn additional income creates an incentive for the workers to properly and efficiently segregate the waste – reducing MCP's production costs. The compost from processing the degradable waste is sold directly to large scale farmers and sometimes through the National Agricultural Advisory Service's (NAADS) established distribution channels. A major source of revenue for the project is anticipated to be from carbon credit claims, for which it receives support from the World Bank. This anticipated revenue from carbon credits has allowed MCP to sell its compost in the initial phase at a very low price to garner market demand. The current unit price of compost is too low for MCP to break even from sales

FIGURE 118. MCP'S BUSINESS MODEL CANVAS





* planned activity

of compost only. Thus eventually MCP will have to increase the product price and ensure revenue receipts from carbon credits in order to fully recover costs. MCP's activities have considerable social and environmental benefits including: a) reduced human exposure to untreated waste; b) reduction in GHG emissions from reduced quantities of landfilled MSW; and c) employment generation to name a few.

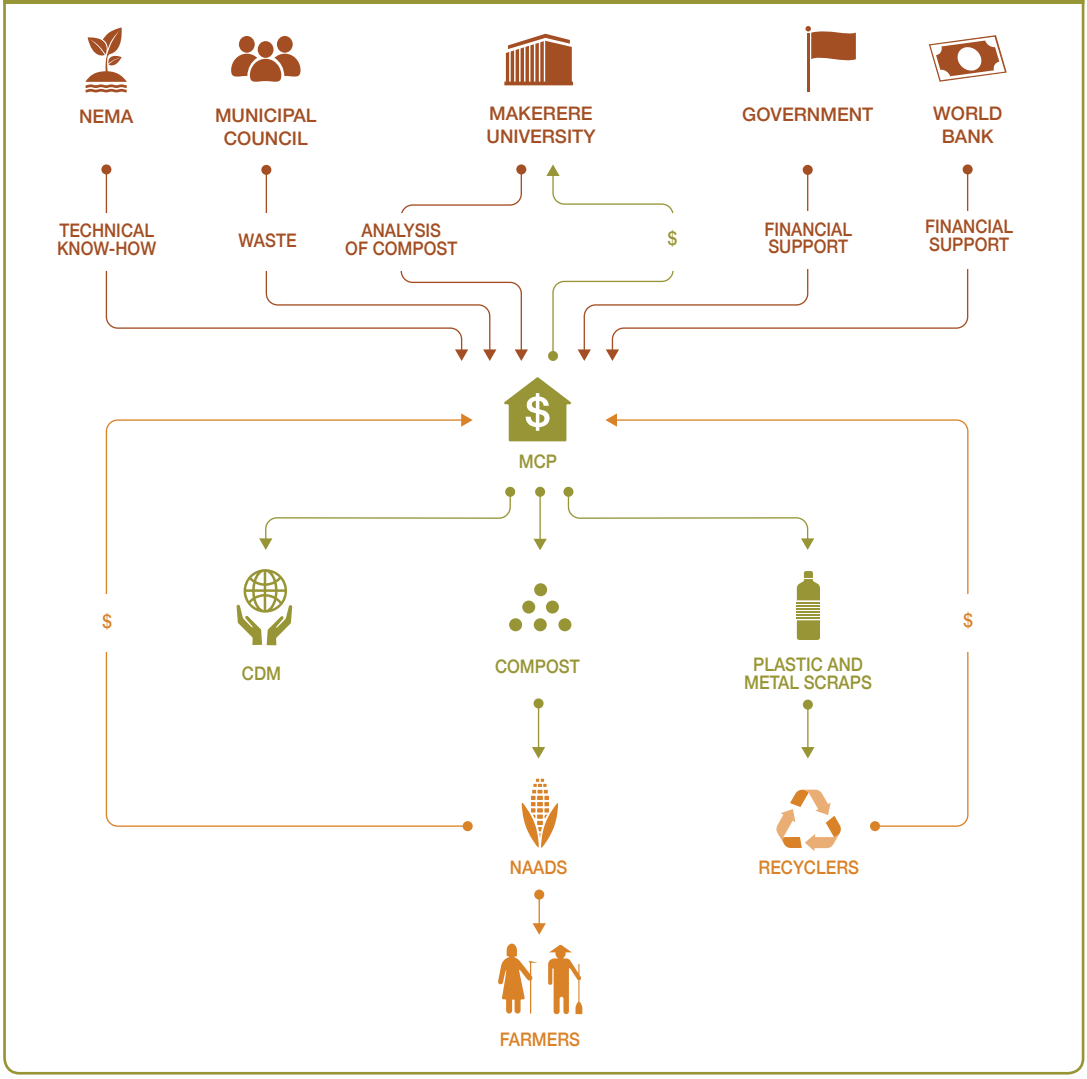
Value chain and position

The central government and World Bank provided funds for the set-up of the business and injected money for operations. MCP partners with Makerere University and NEMA for laboratory analysis to ensure product quality as well as technical support. MCP in turn pays for the services rendered by Makerere University. The Municipal Council supplies MCP with raw materials at no cost. MCP has unlimited access to raw materials (MSW) and does not compete with any other company for the waste input (Figure 119). The compost is sold directly to farmers through NAADS at USD 0.04/kg. MCP's compost competes with chemical fertilizers and other organic fertilizers in the market. MCP has only been in existence for a few years however, the compost produced is gradually gaining popularity in the Mbale municipality. An average of 60 tons of compost is sold on a monthly basis. Currently, MCP captures a very small share of both the organic and chemical fertilizer market, but planned product innovation and new marketing strategies can significantly increase this proportion. Plastics and metal scraps obtained during sorting are managed solely by workers and sold to recycling companies to earn them additional income. Carbon credit sales, anticipated to be the main source of income, has not yet been realized and is still under documentation for application.

Institutional environment

According to a 2011 WaterAid report on solid waste management in Uganda, there is no single document of a legally binding nature, either national or regional, that provides comprehensive solid waste management in Uganda. The Public Health Act Cap.281, 2000, Solid Waste Management Strategy (SWMS) December 2002 as revised in 2006, Local Governments Act (1997) revised in 2004, The Constitution of Uganda 1995 (amended 2005) and The National Environment (Waste Management) Regulations, S.I. No 52/1999 provides some coverage for solid waste management in Uganda. Enforcement of regulations have been challenged with weak punitive measures. The ordinance

FIGURE 119. MCP'S VALUE CHAIN



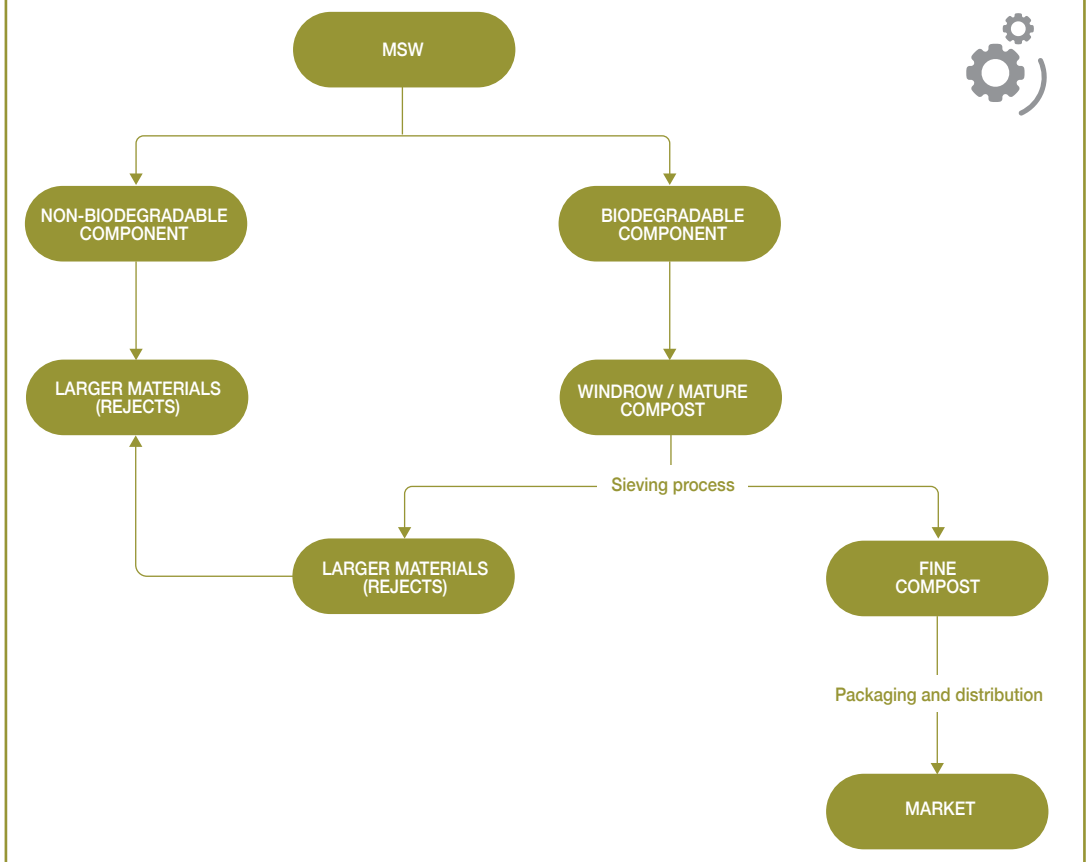
proposes a fee for solid waste generator, however it does not provide a mechanism for collection of these fees, and specifically for Kampala city. Additionally, there were so far no laws or legislations that limit the conversion of human excreta into value-added products or its use. However any organic fertilizer product is to be proven safe and must meet certain minimum nutrient levels – as proven from a product certification from the Uganda National Bureau of Standards. While representative of additional costs to waste-based nutrient recovery enterprises such as MCP, certification of their products represents an avenue for product branding and increased market share.

Technology and processes

The production site is composed of an aerobic composting yard made of concrete flooring and a series of sloping double pitched roofs. The dimensions of the yard are 3,405 m^2 with surrounding drains and it is fully fenced. Municipal solid waste from the urban areas are collected and taken to

the composting plant for segregation. At the plant, the waste is sorted according to biodegradable and non-degradable waste. A windrow composting technique is used for the conversion of MSW to compost (Figure 120). The biodegradable waste is aligned in the first windrow (active stage) where decomposition initially takes place after it is moisturized with recycled leachate and water in order to increase its moisture content. A locally manufactured sieving drum is used to manually separate larger particle material from the fine compost. This is a laborious and inefficient component of the production process. The low level of machinery coupled with high volumes of incoming waste make it difficult to completely compost all the biodegradables. The rejects from the sieving process is landfilled instead of being re-composted. Windrows are designed to have a gentle slope which allows leachate to flow by gravity to the leachate tank. The windrow piles are arranged in order of decreasing size from active to maturation stages because the size of compost is expected to decrease with time. Due to constraints in resources, the intended design of transferring compost from one windrow pile to another is not followed, but instead, it is left in one windrow pile from active to the matured stage. The total time for maturation before sieving is eight weeks, but due to characteristics of the waste, like the presence of fibres, it can take as much as twelve weeks for it to be ready for sieving. Sieving of the mature waste is done manually using slanted sieving drums to allow the compost to go through as the rejects (size bigger than the mesh size) go over to a separate area when rotated. The rejects are then landfilled and the compost is sold to farmers.

FIGURE 120. PROCESS DIAGRAM FOR MCP'S WINDROW COMPOSTING



Funding and financial outlook

The government of Uganda through the municipal council contributed land (which was formally used as a landfill) to the project. It also contributed USD 40,000, which was used to improve infrastructure (e.g. open up roads) and fence the plant area. These funds were from internally generated local revenue by Mbale Municipal Council. Infrastructure including machinery and equipment was funded by the World Bank with a grant of USD 300,000. The municipal council spends USD 13,400 annually on fuel and machine costs. In June 2011, the World Bank contributed a one-time grant of USD 4,800 to help boost the operational performance of the project. It is anticipated that MCP will be able to recover the investment cost in eight years when carbon credit claims are made in addition to the sales of compost. MCP then will have two main sources of income – sale of carbon credits and sale of compost. A kilogram of compost is sold at USD 0.04 as set by the government of Uganda, averaging related revenue of USD 2,000. Although at the time of the study not breaking even, with annual expected earnings of USD 25,000 to 30,000 from carbon credits, MCP expects to not only recover its costs but make some profits.

Socio-economic, health and environmental impact

MCP's activities have accrued significant benefits to society. Its main activity of converting MSW to compost has reduced the quantity of landfilled waste and will result in the reduction of greenhouse gas emissions. Its activities will also reduce waste management costs associated with land acquisition for landfills and their management. Improved sanitation will result in reduced human exposure to untreated waste and associated costs. Improved soil fertility and agricultural productivity from the use of organic fertilizer has noteworthy implications for smallholder farmer livelihoods and food security. Increased crop yields imply increased incomes for farmers and better livelihoods.

Scalability and replicability considerations

The key drivers for the success of this case are:

- Provision of start-up capital by government;
- Funding support from the World Bank and the government to ensure long term revenue flow from carbon credit;
- Incentives to workers for segregating municipal solid waste by allowing them to sell the recyclable waste to recycling companies and earn additional income;
- Weak national chemical fertilizer market and limited access to external chemical fertilizer markets provide ample opportunity for organic fertilizer production business.

The project currently does not break even and cannot achieve this only from sale of compost without process innovation. The manual nature of the activities, e.g. sorting and sieving, results in a high level of inefficiency and limits scaling up of the enterprise. Whilst there are opportunities for scaling-up and out of the project through mechanization of its production system and exploration of new product markets, continued high dependence on external support may still render the initiative unsustainable. It is also imperative that the suitability of technologies to different contexts and product requirements by different markets be taken into consideration.

Summary assessment – SWOT analysis

The SWOT analysis for MCP is presented in Figure 121 below. The key strength of the business is the initial financial support from the government at the start-up phase and funding from the World Bank to apply for CDM process to ensure a stable revenue source. The plant also has good access roads to the site, making the transportation of waste and compost easier. The key weaknesses of the enterprise are related to the highly labor-intensive operations required for waste segregation and its high dependence on external funding. So far, the enterprise hardly generates any revenue from

FIGURE 121. SWOT ANALYSIS FOR MCP'S BUSINESS

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ Continuous availability of raw materials (waste) ▪ Financial support from government and World Bank ▪ Low sales price of compost ▪ Low cost of technology ▪ Good access roads to the site ▪ Sales of CDM enabled in near future	**WEAKNESSES** ▪ Manual operations resulting in high level of inefficiency and high cost ▪ Potentially high occupational health risks from waste segregation process if use of protective gear is not enforced – implications for production costs ▪ Poor marketing strategy ▪ Highly dependent on external support ▪ Inadequate composting facilities
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Mechanization of production process and increasing scale of operations ▪ Sorting of waste at source ▪ Waste collection fees ▪ Increase in the scope of product market ▪ Value addition to compost to increase market share and prices ▪ Weak national chemical fertilizer market and limited access to external chemical fertilizer markets provide ample opportunity for organic fertilizer production business	**THREATS** ▪ Subsidized chemical fertilizer ▪ Increasing labor prices may affect production costs

the sale of compost. This, however, offers an opportunity for it to rebrand its compost product and also add value via fortification and pelletization to command higher market prices and increase its sales revenue. Subsequently, the enterprise could mechanize its operations and increase its scale of operations. The primary threat for the business is subsidized chemical fertilizers and increase in labor prices.

Contributors

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Case descriptions are based on primary and secondary data provided by case operators, insiders, or other stakeholders, and reflect our best knowledge at the time of the assessments 2015/16. As business operations are dynamic, data can be subject to change.

CASE

Public-private partnership-based municipal solid waste composting (Greenfield Crops, Sri Lanka)

Miriam Otoo, Lesley Hope and Krishna C. Rao

Supporting case for Business Model 10	
Location:	Matara, Sri Lanka
Waste input type:	Municipal solid waste (MSW)
Value offer:	Provision of waste management services, and a safe and affordable compost
Organization type:	Public-private partnership
Status of organization:	Established and managed by government from 2005 but entered into a public-private partnership with Greenfields (private company) in 2010
Scale of businesses:	Medium; processes between 300 to 400 tons of MSW per month
Major partners:	Municipal council, Tea Research Institute, Coconut Research Institute, USAID

Executive summary

Greenfield Crops (GC) is a public-private partnership-based (PPP) business which was set up to carry out waste management activities in the Matara municipality. GC adopts an open windrow technology to process municipal solid waste (MSW) into compost. It also produces fuel pellets and sells non-degradable material obtained during the sorting of waste. GC has satellite compost stations which are close to local markets and that provide easy access to waste not requiring significant segregation. Compost is sold directly to farmers through a network of dealers. At the time of this study, the company was not making profits but dependent on government funding. The business is still working to improve their management strategies and the quality of the product to increase its marketability. The compost produced is currently perceived as a soil conditioner by the farmers rather than a fertilizer, and thus to increase its market share GC has to invest in product innovation and new marketing strategies. Activities of the business have improved the local environment and prevented contamination of local water bodies (Nilvala River) as hitherto waste was disposed close to a water body.

KEY PERFORMANCE INDICATORS (AS OF 2015)						
Land use:	25 ha including landfill area					
Capital investment:	USD 1,536,688					
Labor:	15 unskilled labor and 3–5 skilled labor/management					
O&M cost:	USD 9,220 per month					
Output:	300–400 tons per month					
Potential social and/or enviornmental impact:	18 jobs created, clean environment at a low cost, production of compost (soil conditioner) and fuel pellets					
Financial viability indicators:	Payback period:	N.A.	Post-tax IRR:	N.A.	Gross margin:	N.A.

Context and background

The Matara composting plant was set up with funds from the "Pillisaru" project, a Government of Sri Lanka initiative under the Central Environment Authority to improve solid waste management in urban centres. It began its operations – handling of MSW in 2005 – but halted operations due to noted sub-optimalities in the management and marketing of the entity. In 2010, GC revived the business through a PPP agreement for a period of seven years, with the first two years being probationary. Under this agreement, the private entity (GC) pays a service fee of USD 1,500 per month to the public entity (municipal council) for using the infrastructure (land, composting facility and machines). The municipality in turn pays GC USD 5 per ton of waste disposed as a tipping fee. Forty tons of waste is collected daily by the municipal council in Matara city and delivered to several different processing sites. GC started satellite compost stations closer to local markets to minimize transportation costs both for waste collection for the municipality and distribution of compost product for the business – thus increasing farmer accessibility to the organic fertilizers. Plans are underway to establish two additional satellite stations in the Eastern Province.

Market environment

Compost sales have been noted on average to be very low in Sri Lanka. This has been attributed to the low nutrient content of the product and inadequate marketing strategies. Standard compost products found on the market penetrate less than 3% of the fertilizer market. This represents an opportunity for initiatives such as GC to penetrate the market by producing high quality compost products. Chemical fertilizers are subsidized in Sri Lanka and this may represent significant competition for GC[1]. The extensive use and over-application of chemical fertilizers have been detrimental to the soils in the Eastern Province of Sri Lanka so although organic fertilizers may be comparably more expensive, there is a growing demand for them. Soil conditioners are needed to bind the soil particles together and GC's compost product can fill this gap. In Matara, 40 tons of waste is generated every day, of which about 60% is organic. Proper and safe disposal has been a challenge and this has caused public protests. The need for sustainable waste management alternatives is unquestionable – thus initiatives such as that of GC will continue to be in demand at least for the few next decades.

Macro-economic environment

As noted, in Sri Lanka, chemical fertilizer is subsidized by the government and has a higher nutrient value – thus representing significant market competition for GC. The subsidized price of a 50kg bag of chemical fertilizer is USD 2.75 and the same quantity of Greenfield compost is sold at USD 3.17, which is comparatively more expensive as farmers will require a greater application with compost quantity than with the former. Another important market condition that affects initiatives such as GC is related to access to funding. Local funding agencies are hesitant to provide loans to waste businesses as they

are less cognizant of this business sector and classify it as high risk, and thus this factor represents potential constraints to the development of waste reuse businesses. On the other hand, although international donors are more interested in funding these initiatives, they tend to have a preference for public entities rather than private businesses. New waste reuse businesses will have to take these external market factors into consideration and adopt mitigation measures to ensure their sustainability.

Business model

Figure 122 presents an overview of Greenfield Crops' business model and described from the perspective of the private entity engaged in the public-private partnership. GC is a PPP entity charged with the processing of MSW into organic compost. The organic compost produced is sold in local markets through selected retailers. Plantation farmers such as tea, cinnamon and coconut farmers are the main users of the organic compost produced. Under the PPP, GC is the private entity and the municipal council is the public entity. The composting facility as well as land and other infrastructure were set up by the municipality. GC only manages the business and bears the cost of operations and maintenance. It pays the municipal council for the use of the resources provided, i.e. the composting facility and equipment. The municipal council on the other hand pays GC tipping fees for the disposal and processing of the solid waste. GC also partners with research institutes (Tea Research Institute and Coconut Research Institutes) for product quality analysis and USAID, who provided funds for the establishment of a laboratory. Essential to this model are the satellite compost stations that GC operates. These stations are close to local markets and farmers, resulting in minimizing transportation costs for waste collection for the municipality and distribution of compost product for the business – thus increasing farmer accessibility to the organic fertilizers. GC sells its compost at a flat price exclusive of transportation fee. Traders add on the cost of transportation and sell it at their preferred prices up to a specified limit[2]. A small quantity of recyclables is also sold to recycling units. While this initiative is currently still dependent on government funding, with plans to increase its scale of production via additional satellite stations, full cost-recovery is certainly achievable in the near future. GC's activities have accrued significant benefits to the society including: a) creation of jobs; b) reduced waste management costs; and c) improved environmental health.

Value chain and position

Figure 123 presents an overview of GC's value chain. The initiative receives MSW from the municipal council which pays USD 5/ton as tipping fees for waste disposed and processed. GC, on the other hand, pays the municipal council for use of the composting facility and other infrastructure. Matara municipal council is the sole provider of the MSW and hence has a strong supplier power which would be a major production risk factor for GC. However, given the nature of the PPP agreement, this power cannot be executed by the municipal council and is mandated to deliver the waste to the business. GC partners with the Tea and Coconut Research Institutes for field trials and product quality analysis. Field experiments have shown that there is a tremendous yield increase when GC's compost is used, suggesting a potentially significant demand if farmers do adopt compost use at least as a complementary product. The final compost product is sold directly in the local markets through a network of retailers. GC's key customers are farmers, specifically tea, rubber, coconut, cinnamon and other cash crop farmers. The business entity does not consider the product as an organic compost but rather as a soil conditioner. Since the customers are diverse, buyer power is relatively mitigated. There are no barriers to entry into the composting business, however, the municipal council owns the waste and permission is required and GC currently has the sole agreement with the municipality.

FIGURE 122. GREENFIELD CROPS' BUSINESS MODEL CANVAS

KEY PARTNERS

- Municipal council
- Tea Research institute
- Coconut research institute
- USAID

KEY ACTIVITIES

- Treatment of municipal solid waste
- Production of compost
- Sales of compost and other non-degradable materials
- Management of the satellite compost facilities
- Product quality analysis

KEY RESOURCES

- MSW
- Land
- Composting facilities
- Equipment
- Laborers
- Partnership agreements
- Network of satellite compost stations

VALUE PROPOSITIONS

- Provision of quality soil conditioner and organic fertilizer meeting tea and coconut planation farmers' requirements
- Provision of improved sanitation and waste management services
- Recovering of non-degradable recyclable materials from segregation of MSW

CUSTOMER RELATIONSHIPS

- Personal relationship with traders (with a price ceiling for negotiation)
- Direct interaction with municipality to provide waste
- Direct relationship

CHANNELS

- Local market through a selected set of retailers
- Compost facility provided by the government, O&M is performed by the private entity
- Direct

CUSTOMER SEGMENTS

- Farmers (cash crop, tea, coconut, cinnamon growers)
- Municipal Council, with the direct beneficiaries being the city dwellers
- Buyers of non-degradable materials

COST STRUCTURE

- Rent of the composting facility
- Operation and maintenance cost (maintenance of machinery, quality control and labor cost)

REVENUE STREAMS

- Sales of compost
- Tipping fee for disposal and processing of solid waste
- Sales of non-degradable materials

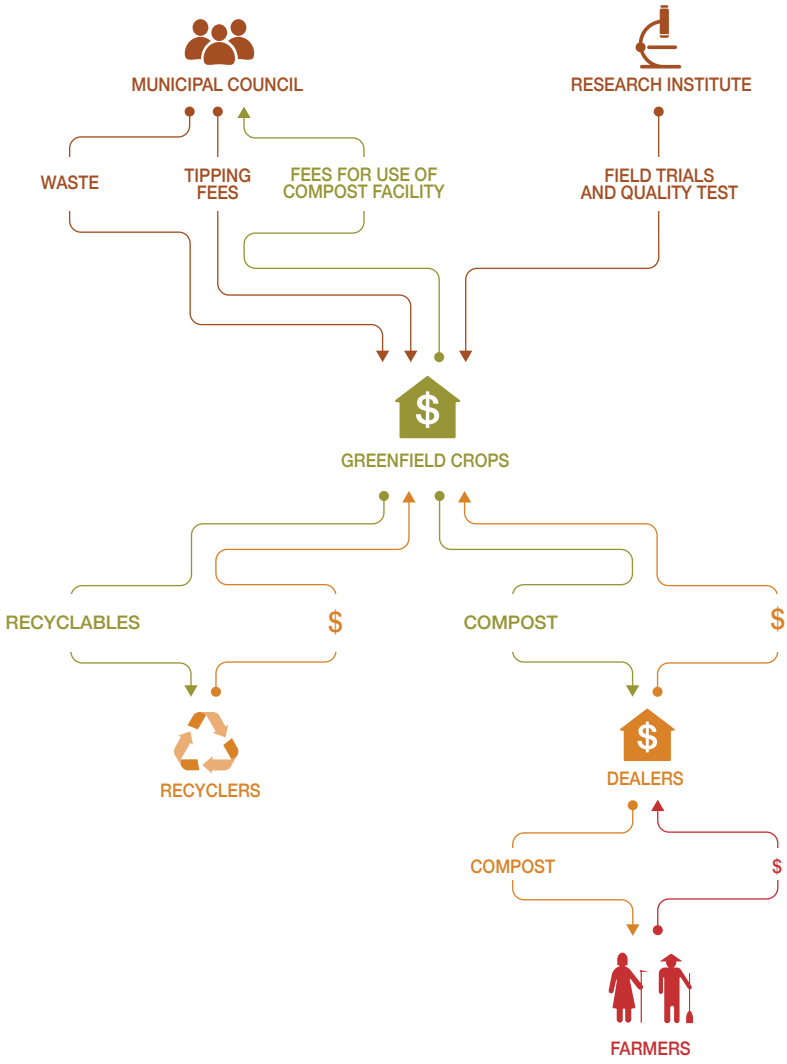
SOCIAL & ENVIRONMENTAL COSTS

- None noted based on data provided

SOCIAL & ENVIRONMENTAL BENEFITS

- Reduction of waste generated in the municipality
- Reduces existing waste management costs
- Reduces human exposure to untreated waste
- Creation of jobs

FIGURE 123. GREENFIELD CROPS' VALUE CHAIN



Institutional environment

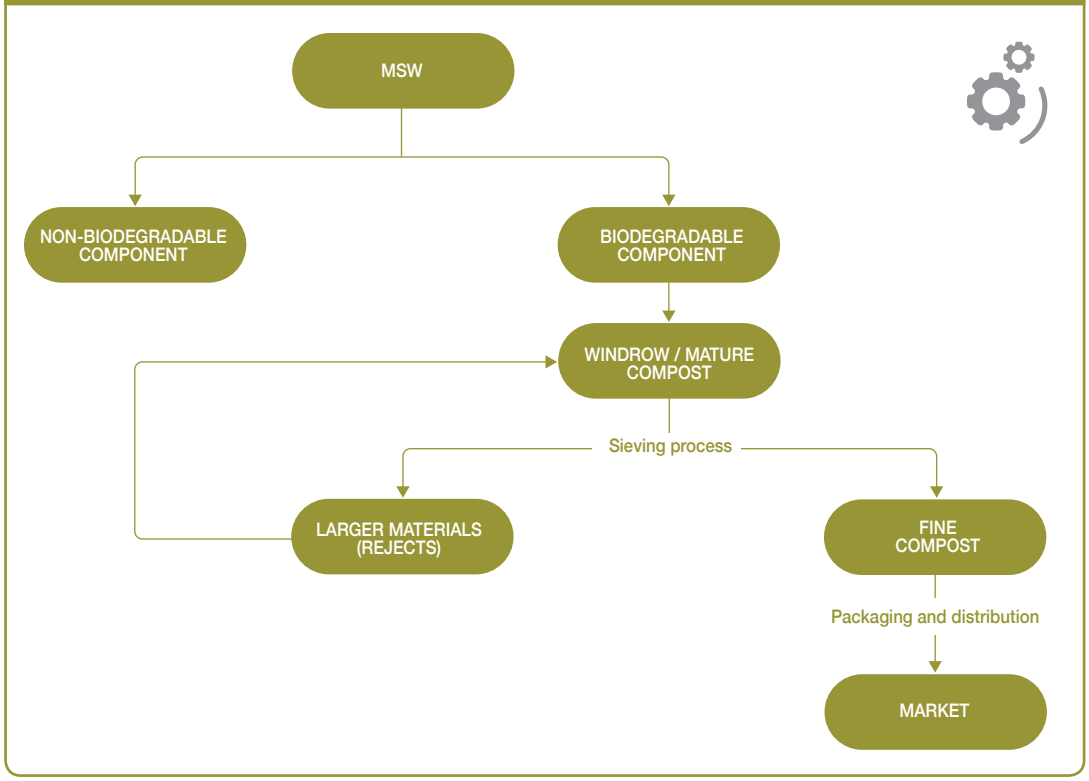
In 2007, the National Policy on Solid Waste Management was formulated that replaced the 2000 National Strategy for Solid Waste Management which targets waste minimization, reuse of waste, recycling and appropriate final disposal of waste. Under the national policy, the government allocates funds for the capital investment of solid waste management projects. While there are so far no laws that prevent the reuse of treated MSW and fecal sludge, all waste reuse businesses in Sri Lanka require permits, certifications and an approved environmental impact assessment prior to starting operations. The Sri Lanka Standards Institution (SLS) is responsible for the development of national standards for products and services used mainly in the industrial and trade sector. SLS has developed standards for the production and marketing of compost and other organic inputs – SLS 1246:2003, UDC628.477.4 (CEA, 2005). This standard requires quality monitoring of the compost product by certified third party

local authority and submission of results to the SLS monitoring committee. Compliance to these standards not only ensures the sustainability of compost businesses but it allows GC to self-brand their product and increase their market share.

Technology and processes

Greenfield Crops uses an open-windrow system for the processing of MSW to compost (Figure 124). The technology is locally manufactured, which reduces the investment cost but also some related maintenance costs as replacement parts can be purchased locally. The MSW is first sorted into degradable and non-degradable fractions. The biodegradable waste is aligned in the windrow where decomposition takes place. Piles are turned once a week to promote aerobic digestion minimizing the odor from decomposition as much as possible. The complete process takes about 45–60 days depending on weather conditions. The duration of each stage also depends on the composition of the waste received. At the end of the composting period, piles are kept for further maturation. The matured waste is then sieved and fibrous materials that degrade slowly are added back to new piles. The sieved material is packaged and sold.

FIGURE 124. PROCESS DIAGRAM FOR GREENFIELD CROPS



Funding and financial outlook

Construction of the composting facility was fully funded by the 'Pillisaru' project of the Central Environmental Authority at a cost of USD 1,540,000. GC spends USD 9,240 per month for its operations. The operational cost includes electricity, fuel, worker wages, repair and maintenance and the service

fee. Electricity and fuel cost alone account for 77% of the operation cost. The business generates revenue from sales of compost, non-degradable and tipping fees at a rate of USD 5 per ton of MSW received. The company processes forty tons of waste on a daily basis, amounting to USD 6,000 per month as tipping fees. Monthly sales of compost and non-degradables averages about USD 15,400 and USD 355, respectively. Although representative of 70% of all generated revenue, the enterprise remained unable to sell all of its compost and is working on implementing a new marketing strategy to boost sales and increase its profits.

Socio-economic, health and environmental impact

The PPP has saved the municipal council a significant amount of money which hitherto was used in operating the composting business as it was incurring losses. Additionally, through charges for the use of the composting facility and equipment, it is able to implement a mutual financial sustainability strategy. The activities of GC have rid the municipality of indiscriminate waste disposal while tidying up the city and reducing water pollution. The business has also provided jobs for some low-income earners, but the process of manual sorting, sieving and packaging may present occupational health risks as well if proper mitigation measures are not adhered to.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Given the scale of operations, the PPP arrangement is ideal for this business set-up – public sector constructs the infrastructure and provides the capital cost required for equipment, and private sector brings in sophisticated management and skills to operate the facility.
- Government policy encourages reuse and recycling and sufficient incentives such as tipping fees have been provided to keep the private sector interested in managing the facility.

GC has adopted a system of compost production where compost is produced at vantage points close to local markets. The technology used is simple, and requires limited technological expertise and energy, making it highly replicable. Waste segregation is a primary cost component as well as a major source of inefficiency and thus scaling up may optimise production, as benefits will outweigh costs. A major limitation is the high capital investment requirement for land and especially in localities that are yet to be developed in terms of infrastructure, e.g. roads. This model is highly replicable in large cities with significant waste generation. However, limitations of land availability, competition in the product market and technological adaptations have to be taken into consideration.

Summary assessment – SWOT analysis

The SWOT analysis for GC composting plant is presented in Figure 125. The key strengths of the business are: a) the support from municipal authority, and b) innovative production system of satellite stations which increase its access to the waste source and product markets via reduced transportation costs. A key weakness of the PPP is the high investment requirements for future expansion and the labor-intensiveness of waste segregation. The latter represents a potential risk to the business in the instance where labor wages rise – which would imply the adoption of a new technology or increasing their labor prices to maintain their staff. GC generates a comparably low amount of money from the sales of recyclables. There are opportunities for the business to increase its revenues via value-addition to the plastic materials (via shredding and pelletization) which would command higher prices but also access new markets. Given the success of this public-private partnership, this model could be potentially replicated in other towns and cities in Sri Lanka. Many factors including competition in the fertilizer market, technology adaptation, among others need to be taken into consideration.

FIGURE 125. SWOT ANALYSIS FOR GREENFIELD CROPS

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ Soil conditioning characteristics with water and nutrient retention capacity of the product ▪ Support from municipal authority ▪ Compost satellite stations close to waste source and product markets ▪ Adequate and continuous supply of waste ▪ Limited technological expertise needed	**WEAKNESSES** ▪ High investment requirements ▪ Limited access to loan ▪ Inadequate marketing strategies ▪ Nutrient content of compost is fairly low ▪ Technology (sorting) is labor intensive ▪ Technology efficiency dependent on weather conditions
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Production of fuel pellets from non-degradable and increasing sales of recyclables ▪ Replicating similar model for other towns in Sri Lanka ▪ Strong potential for tapping carbon market as an additional revenue source given scale of business ▪ SLS regulation allows for self-branding upon compliance ▪ Government policy allotting funds for solid waste management projects	**THREATS** ▪ High subsidy for chemical fertilizer ▪ Increasing labor wages present potential production risk for business

Contributors

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Personal communication with staff of Greenfield Crops. 2015.

Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2015/16. As business operations are dynamic, data can be subject to change.

Notes

1 Fertilizer subsidy scheme (fixed price for Nitrogen (urea), Phosphorus (TSP), Potassium (MOP) at Rs. 350/50kg) in Sri Lanka was changed in 2016 to a cash payment of Rs. 25,000/ha/year for paddy farmers. (USD 1 = approx. Rs 140).
2 Price information details were not provided.

CASE

Fecal sludge and municipal solid waste composting for cost recovery (Balangoda Compost Plant, Sri Lanka)

Miriam Otoo, Krishna C. Rao, Lesley Hope and Ishara Atukorala

Supporting case for Business Model 10	
Location:	Balangoda, Sri Lanka
Waste input type:	Municipal solid waste (MSW) and fecal sludge
Value offer:	Provision of MSW-based compost ('regular' compost), fecal sludge-based compost ('super' compost) and treated wastewater
Organization type:	Public entity
Status of organization:	Operational since 1999 but was privatized in 2003 and restored to government again in 2005
Scale of businesses:	Small to medium; processes more than 300 tons of MSW/month
Major partners:	Central Environmental Authority, Municipal Council, Universities, LIRNEasia

Executive summary

Balangoda Compost Plant (BCP) is a public entity that converts MSW into compost, and by adding also night soil[1] into super compost, as well as treating of water and trading of recyclables. It was set up to curb environmental and sanitation problems in Balangoda, in particular, indiscriminate disposal of night soil and solid waste accumulation. It uses the open-windrow processing technology to compost municipal solid waste. A simple approach with limited energy requirements is used in treating night soil, where water purifying plants and charcoal filters are used to treat the wastewater in the fecal sludge. Although geared towards cost-recovery and receiving partial financial support from the central government, BCP generates significant income from its multiple revenue streams – sale of compost and recyclables. MSW-based compost and super compost are sold directly to farmers through agro-outlets in local markets. Other government bodies, such as the Urban Development Authority and the Ministry of Agriculture, buy directly in bulk for landscaping. There is however no market for the treated water (leachate product). Resource centres where non-degradable waste is traded have been established in the city centre and at ten schools. BCP purchases segregated non-degradable waste from these resource centres and schools and resells to recycling companies at a higher price. This initiative has significantly reduced direct human contact with untreated waste and provided an improved environment for the community through proper waste management practices in the region. Additionally, it has created jobs and improved infrastructure via the construction of access roads to the project site. It has also caused an attitude change towards waste among the younger generation.

KEY INDICATORS (AS OF 2015)						
Land use:	1 ha					
Capital investment:	USD 352,000 including costs of 1 hectare of land					
Labor:	17 people (15 unskilled, 2 skilled)					
O&M cost:	USD 1,340 per month					
Output:	30 tons of compost, 5 tons of super compost and 180,000 litres of treated water, all on a monthly basis					
Potential social and/ or enviornmental impact:	17 jobs, production of high quality and affordable compost and super compost, treated water, changed attitude of children to waste, cleaner local environment					
Financial viability indicators:	Payback period:	N.A.	Post-tax IRR:	N.A.	Gross margin:	N.A.

Context and background

The Balangoda Compost Plant (BCP) was set up to process municipal solid waste into compost. The plant started as a project with the mission of providing a solution to the solid waste problem as a community service. However, it gradually evolved into a business while providing community service. Balangoda is situated in Sabaragamuwa province of Sri Lanka, with a population of more than 40,000 and a land area of 16.2 km^2. The plant was started in 1999 and it has undergone several changes in ownership structure; it was set up and managed by the government but privatized after a change in government. The ownership was again transferred to the government when the private entity neglected safe handling of waste and focused completely on profits. Construction cost of the compost plant and the access roads were funded by Central Environmental Authority and Provincial Council. The land was given to the project at no cost by the Land Reform Committee. As a rejuvenated project in 2003, it embarked on cleaning the city in the night including collection of waste which was appreciated by the people and the decision makers resulting in further allocation of funds to improve the plant. By 2005, funding and revenue received was used to purchase the required machines and with the help of the municipality, a resource centre was built to purchase non-degradable waste in the city. The plant procured plastic and polythene pelletizers to add value to the non-degradable waste which reduced related transportation cost from product distribution. In 2008, a fecal sludge treatment plant was established with funds from the "Pillisaru" project of the Central Environmental Authority. Funds were used to construct a receiving tank, 2 sedimentation tanks, a water treatment facility and a drying bed. The majority of the building has been constructed from the funds and subsidies provided by the government. BCP earns revenue from sale of compost, super compost and recyclables. A twelve-year target of making a 'Waste Free City' has been achieved by the plant whereby all generated waste in the city is collected and treated.

Market environment

Waste accumulation in the city caused many problems including unpleasant odor, contamination of water bodies and paddy fields, giving rise to epidemic diseases like Salmonella typhoid and diarrhoea. This has resulted in a great need for the implementation of sustainable waste management solutions. Soils in the Eastern province of Sri Lanka are traditionally very sandy and chemical fertilizers leach out of the soil at a faster rate without the application of soil conditioners. Additionally, the over application of chemical fertilizers has damaged a considerable proportion of the soil structure and has rendered most of the lands unsuitable for agricultural production. Government and farmers in the Eastern province of Sri Lanka realize the importance of organic fertilizer use to mitigate the long-term damage of agricultural lands. This has resulted in an increased demand for organic compost in the Eastern Province. BCP sells an average of five tons of compost per month of which 40% is sold in the locality and 60% in the Eastern province and foresees an increasing trend in demand.

Macro-economic environment

The introduction of cash payment-based subsidies for chemical fertilizers may affect the demand of organic fertilizer in the locality. BCP is largely focusing on the Eastern province fertilizer market where organic fertilizer is in high demand due to the poor structure and declining fertility of the soils. The demand for chemical fertilizers is fairly high country-wide and this has been one of the driving factors for price subsidization by the government. A 50kg bag of chemical fertilizer at the subsidized rate is sold between a range of USD 2.75–3.07 and organic compost produced by Balangoda composting plant is sold for USD 3.14. BCP faces strong competition from both chemical and organic fertilizer businesses (Table 34).

TABLE 34. PRICES OF ORGANIC AND INORGANIC FERTILIZERS IN SRI LANKA 2015

FERTILIZER TYPE	PRICE (USD/50KG)
Organic fertilizer – Balangoda composting plant	3.14
Organic fertilizer – Nawalapitiya	2.74
Chemical fertilizer	2.75 – 3.07

Business model

Figure 126 provides an overview of the Balangoda Composting Plant's (BCP) business model. It is a public entity that processes municipal solid waste (MSW) and fecal sludge (FS) into organic fertilizers, treats leachate (wastewater) and sells recyclables (non-degradable waste). The enterprise was set up with the intent of providing community service and is not profit-oriented. The plant employs a value-driven model, where quality of the product is the main focus. For instance, the nitrogen content of the compost from MSW and FS are 1.68 and 2.9 respectively, compared to an average of 0.5–0.7 found on the market. It also adapts a demand driven approach where compost is sold to farmers that have need of the product, i.e. localities where soils are sandy in nature and thus require soil conditioner to bind soil particles together. Organic compost from both MSW (regular compost) and FS (super compost) are sold to farmers within the locality, as well as to the farmers in the Eastern province of Sri Lanka. As a part of its marketing strategy and to expand its customer base, BCP gave all its first-time customers free compost samples so that they could witness increased yields on their own farms. This has been instrumental in increasing its market share. An additional source of revenue is from the sale of recyclables which are bought from locals and sold directly to recycling companies at higher prices. There is no market for the treated wastewater. BCP has partnered with the Pillisaru Project which contributed funds for the construction of tanks and drying beds required for the production of the super compost. It is important to note that this was a one-time contribution, and whilst a partner to BCP, they are not a key partner in the business model, since it has no continued role in the business. Another key partner has been the local university for laboratory analysis of wastewater and with LIRNEasia[2] for technology development and skills training of the staff. A key success factor of this business has been its ability to liaise with the urban council to enact a waste tax for shops and institutions that fail to segregate waste. This has tremendously reduced the costs associated with waste sorting and sped up the entire production process. Waste resource centres have been implemented in schools. Students have been trained on waste segregation and the benefits of waste reuse which has resulted in an attitudinal change among the young generation.

Value chain and position

Figure 127 provides an overview of BCP's value chain. The Balangoda compost plant is a public entity owned by the municipal council. It receives its major input, i.e. municipal solid waste and fecal sludge, from the council and commercial companies. It partners with universities and LIRNEasia for research

FIGURE 126. BALANGODA COMPOST PLANT'S BUSINESS MODEL CANVAS

KEY PARTNERS

- Central Environmental Authority
- Municipal Council
- LIRNEasia
- Universities

KEY ACTIVITIES

- Collection and separation of waste
- Production and sale of compost and super compost
- Trading of recyclables
- Awareness raising activities at educational institutions

KEY RESOURCES

- Machinery
- Land and labor
- MSW
- License (fertilizer manufacturing and environmental impact assessment)

VALUE PROPOSITIONS

- Provision of improved sanitation and waste management services
- Provision of high nutrient compost and super compost for farming activities and landscaping
- Recycling companies get to buy recyclable wastes at an affordable price

CUSTOMER RELATIONSHIPS

- Personal collection of waste
- Personal help at direct sales (marketing strategy adapted where samples are given to farmers free of charge the first time)
- Personal

CHANNELS

- Direct
- Local market through a well-constructed market chain and direct channel to bulk buyers
- Waste resource centres and school children to collect recyclables and direct sale to recycling companies

CUSTOMER SEGMENTS

- Commercial firms and residents of Balangoda
- Farmers within locality and Eastern province farmers
- Bulk buyers: Government authorities (Urban Development Authority for Landscaping and Ministry of Agriculture)
- Recycling companies

COST STRUCTURE

- Investment Capital cost (including receiving tanks, sedimentation tank, plastic and polythene pelletizer, water treatment facility and drying bed)
- Operation and maintenance (maintenance of machinery, quality control and labor cost)
- Purchase of non-degradable waste from resource centres

REVENUE STREAMS

- Waste collection funds from government and waste tax from commercial entities that do not segregate waste
- Waste collection fees collected directly from some commercial entities such as fish market, vegetable market etc.
- Sales of compost and super compost
- Sales from non-degradable waste

SOCIAL & ENVIRONMENTAL COSTS

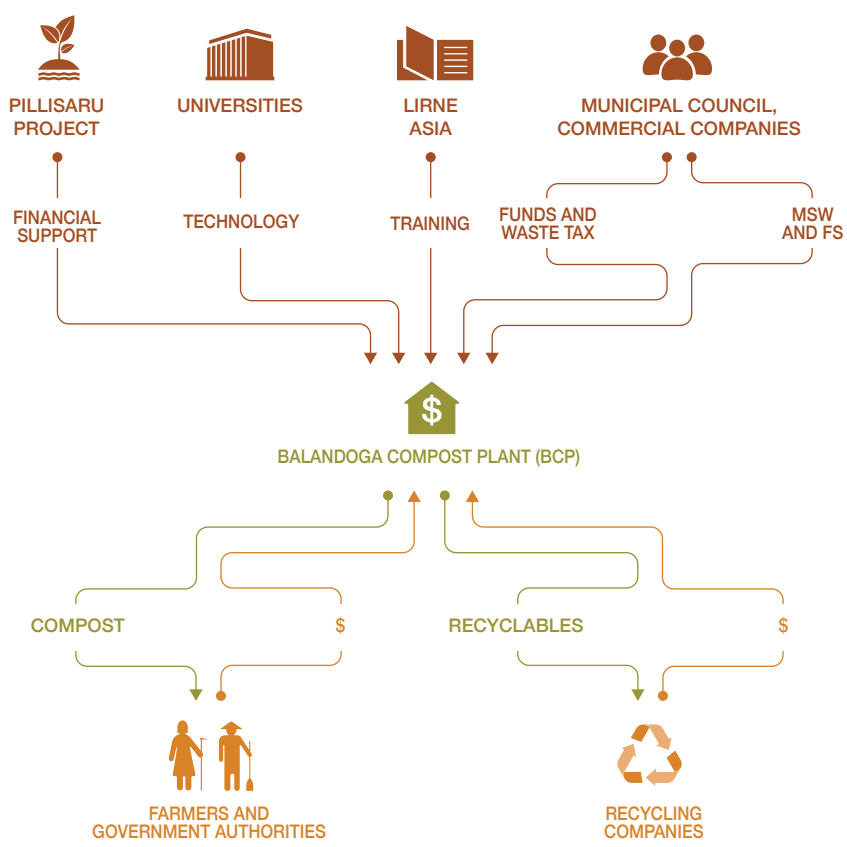
- Possible pollution of water bodies from leachate

SOCIAL & ENVIRONMENTAL BENEFITS

- Reduction of waste generated in the municipality
- Reduced existing waste management costs
- Possible reduction of pollution of water bodies from reduced indiscriminate disposal of fecal sludge
- Reduced human exposure to untreated waste
- Creation of job opportunities
- Improved food security

into technology development and skill training respectively. The partnership with the university is a win-win situation where students from the universities (Sabaragamuwa and Jayawardena) use the composting site for research activities and the enterprise also benefits from the resulting research outputs. Key products, i.e. compost and non-degradable, are sold directly to locals through the local markets from agro-shops. Government institutions such as Road Development Authority are continuous buyers, but no agreements or partnerships exist between them. Products are supplied on occasional demand. The municipal solid waste used by BCP is collected and managed by the urban council. BCP has the urban council as its primary supplier of waste and hence the supplier power is high. Subsidized chemical fertilizer has a lower price compared to the organic fertilizer and has reduced the demand of organic fertilizer in spite of its nutrient retentive capacity. BCP must thus maintain a price lower than the subsidized chemical fertilizer to penetrate the market. Chemical fertilizer and other organic compost are good substitutes of the organic fertilizer produced by BCP. High price of organic fertilizer attributable to subsidies on chemical fertilizer and high application frequency has created demand for chemical fertilizer over organic fertilizers. The threat of new entrants into municipal solid waste processing is low due to the fact that the urban council owns waste and a permit is required to collect or process waste. In addition, waste recycling businesses are limited by institutional structures.

FIGURE 127. BCP'S VALUE CHAIN



Institutional environment

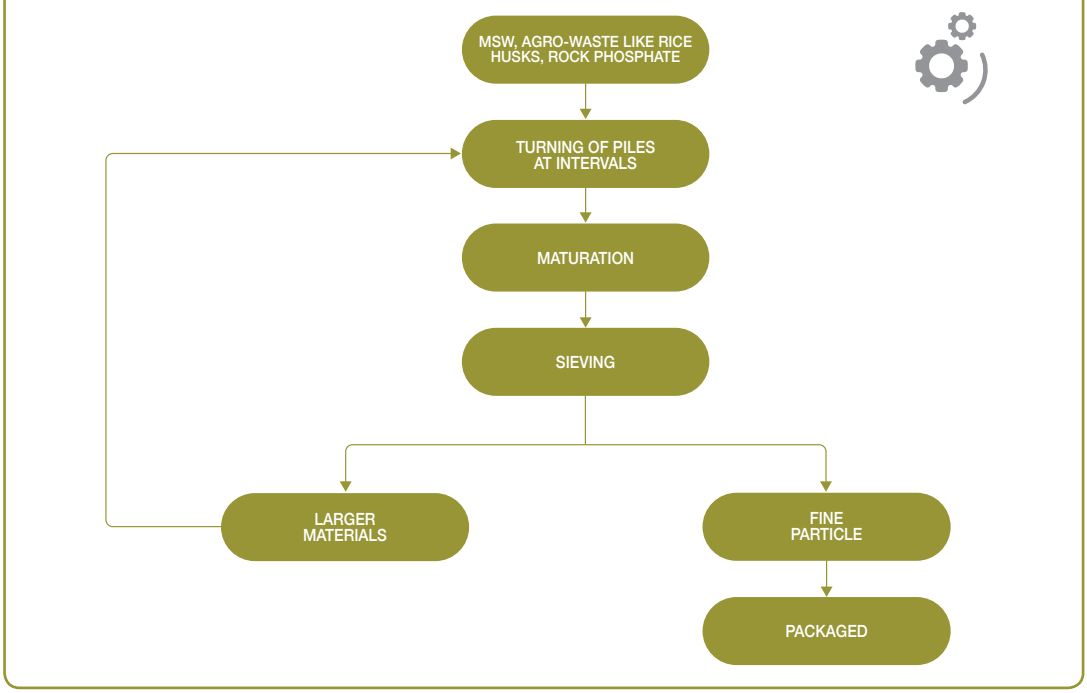
In 2000, the Government of Sri Lanka passed the national strategy for solid waste management that targets waste minimization, reuse of waste, recycling and appropriate final disposal of waste. In 2007, a new policy was formulated and implemented – the National Policy on Solid Waste Management to replace the 2000 National Strategy for Solid Waste Management. Under this new policy, the government annually allots funds for the capital investment of solid waste management projects such as Balangoda. There are currently no laws that limit the reuse of treated MSW or FS. However, all waste reuse businesses in Sri Lanka require permits and certifications prior to starting operations. This is inclusive of an environmental impact assessment to be conducted by a certifiable third party on an annual basis. The Sri Lanka Standards Institution (SLS) is responsible for the development of national standards for products and services used mainly in the industrial and trade sector. The division consists of sections namely agriculture, food, chemicals and cosmetics and textiles. SLS has developed standards for the production and marketing of compost and other organic inputs – SLS 1246:2003, UDC628.477.4 (SLS, 2014). This standard requires quality monitoring of the compost product by certified third party local authority and submission of results to the SLS monitoring committee. Additionally, this standard has set requirements for nutrient levels, biological and microbiological requirements and limits of heavy metals. Compliance to these standards not only ensures the sustainability of compost businesses, but it allows them to self-brand their product and increase their market share.

Technology and processes

Production of MSW-based compost

BCP uses the open-windrow system for the processing of municipal solid waste into compost (Figure 128). The technology has a high rate of recovery for bulky materials, and is thus suitable

FIGURE 128. PROCESS DIAGRAM FOR PRODUCTION OF BCP'S MSW-BASED COMPOST

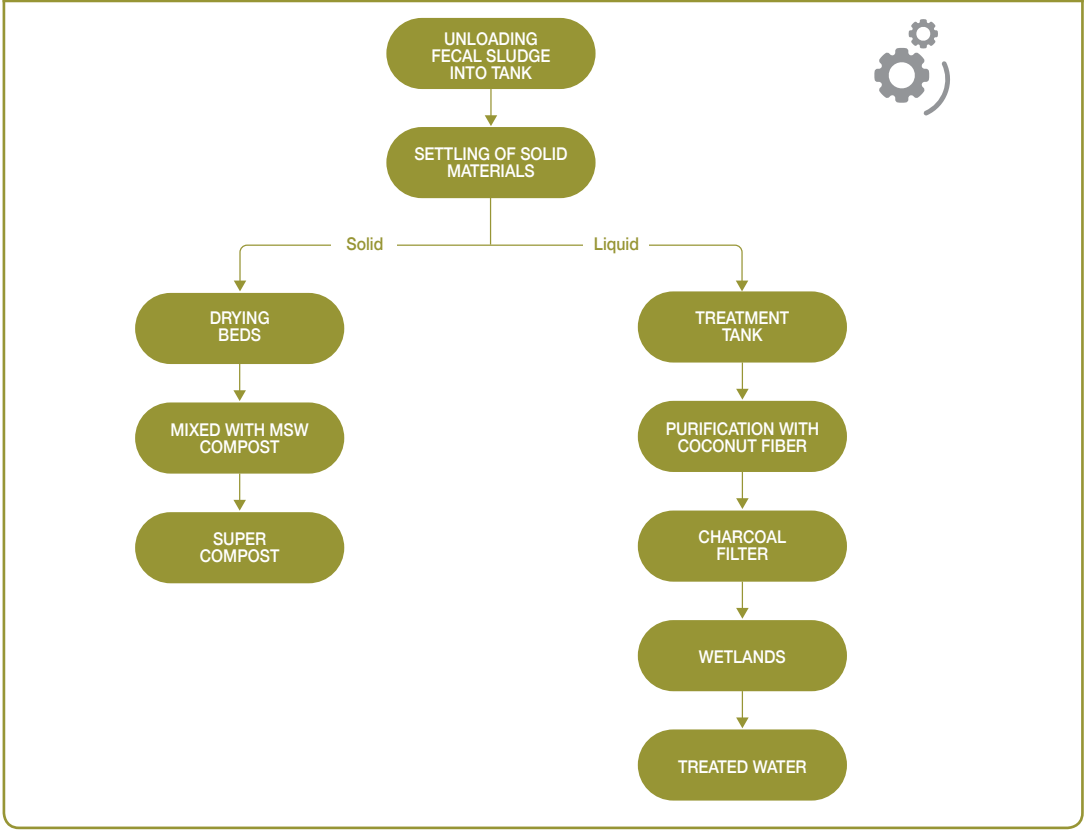


for composting large volumes of waste. The equipment is locally manufactured which considerably reduces the investment cost. However, the maintenance cost of equipment is high and it is not space efficient. Sorted MSW is piled up to a size of 5x5x12 feet. Every pile is maintained for six weeks. A temperature of nearly 70°C is maintained inside the pile, which minimizes pathogens including harmful helminths (worms) and fly larvae. Rock phosphate is also added to increase the phosphorus content of the final product. Since the composting site is situated just 25 feet away from the households, efforts are been made to maintain the aerobic conditions thus the piles are mixed at appropriate intervals (at least once a week) maintaining temperature, moisture and amount of air inside the pile. Leachate is collected six hours after the open windrow preparation and this is mixed with water in the ratio of 1:1,000 and sprinkled back on the composting piles for temperature regulation. Once the composting process is over, the piles are left for maturation for one to two weeks where pathogenic fungi such as Aspergillus are eliminated due to the drop of moisture level to around 5%. The compost is then sieved through a 6mm sieve to get fine particles of compost (the stated standard range for particle size is 4mm to 10mm). Before packaging, the moisture level of the compost is increased to 15%.

Production of fecal sludge and municipal solid waste-based co-compost

The treatment of fecal sludge involves a simple approach that does not require any energy except sufficient sunshine (Figure 129). The collected fecal sludge is unloaded into settling tanks and kept there for 45 minutes for the solid material to settle. The liquid portion is then taken into a treatment

FIGURE 129. PROCESS DIAGRAM FOR PRODUCTION OF BCP'S 'SUPER' COMPOST



tank where coconut fibres are used to create microenvironments rich with micro-organisms that purify the wastewater. This water is passed through a charcoal filter to a constructed wetland for further treatment. The solid matter is sent to two drying beds where they are stored for 28 days. This dried fecal matter is mixed with the MSW-based compost to produce a co-compost (super compost). The product is termed '*super compost'* because the addition of the dried fecal sludge increases the nutrient content and levels of the final product.

Funding and financial outlook

The Central Environmental Authority and the Provincial Council funded the construction of the compost plant and roads at the cost of USD 300,000. The land was provided by the Land Reform Committee at no cost. Operation and maintenance cost is estimated at around USD 1,340 per month. The initial operation costs were catered for by the municipal council until the project began making profit. The Central Environmental Authority together with the urban council funded the construction of the fecal sludge treatment plant at a cost of USD 51,000. Collection centres for non-degradable and associated infrastructure were also established at a cost of USD 3,200. Apart from the recovered resources from organic material, the municipality sells non-degradable materials to recyclers. Acting as middlemen in the business, the urban council doubles the price paid for non-degradable products and earns 100% profit. Collection fees are taken only from several private fish markets, private farms and private meat markets. They are very few in the town. But significant revenue is generated from the waste tax charged to entities that do not segregate their waste. This sums up to USD 3,900 per annum. In 2011, the council made a profit of USD 165 from compost and USD 1806 from sales of non-degradable products. BCP envisions earning additional income from the sale of processed plastics.

Socio-economic, health and environmental impact

The benefits from BCP's activities are multi-fold. This plant has considerably reduced the municipality's waste management cost and also generates additional income beyond cost-recovery. Seventeen workers from the locality are provided with employment. Farmers benefit from the use of high quality and affordable organic fertilizers. The composting plant, in addition to managing municipal solid waste, treats fecal sludge from onsite sanitation systems in Balangoda, thus reducing indiscriminate dumping of fecal sludge. Residents of Balangoda have thus benefited from reduced exposure to untreated waste and improved sanitation which has reduced considerable health risk and surface and groundwater contamination. BCP is an example of an initially fully subsidized compost plant which has been able to transition to a financial self-sufficient business via the implementation of a suitable marketing scheme and strategic partnerships.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Strong funding support from the government and policy that encourages reuse and recycling.
- 2007 government act enabling self-branding.
- Diverse customer base in terms of geographical outreach and strong awareness amongst from farmers in the Eastern province on the need for organic fertilizer.
- Clear awareness among farmers concerning soil degradation and the different effects of organic and chemical fertilizers.

BCP uses a near holistic approach to resource recovery and reuse where almost all waste types, both degradable and non-degradable, are either reused or recycled. The technology adopted is simple, requires limited expertise and energy, making it highly replicable. Waste segregation is a primary cost component while processing waste as well is a major source of inefficiency. BCP mitigates these inefficiencies via the creation of waste resource centres for the segregation of the non-biodegradable

waste and thus significantly reducing production costs. A major limitation with implications for replication is the high capital investment requirements for land and in localities that are yet to be developed –infrastructure, e.g. roads. Another challenge to replicating this model is getting support from municipal council to enable a company (private or public) institute a waste tax to reduce the receipt of unsorted waste and essentially minimize costs so as to ensure sustainability.

Summary assessment – SWOT analysis

The SWOT analysis for BCP is presented in Figure 130. The key strengths of the business are: a) the low-cost technology; b) segregated waste delivered to this composting plant; c) funding from government to cover capital and initial operating cost; and d) governmental support to institute waste tax for entities who do not segregate waste. The BCP business however has a couple of weaknesses related to limited land availability for future expansion and its dependency on external entities for waste segregation. In the future if waste resource centres are unable to manage their operation cost, BCP will have to heavily invest in both capital and operational costs for segregating their waste. There are several opportunities in which BCP can tap into: a) compliance to certification standards will not only contribute to the sustainability of the compost business but it will allow them to self-brand their product and increase their market share; b) the enterprise can develop different formulations of

FIGURE 130. SWOT ANALYSIS FOR BALANGODA COMPOST PLANT

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ Receives segregated waste thus reducing production cost ▪ Technology compatible with the topography and requires limited energy ▪ Low cost technology ▪ Technology requires low level technical skills or expertise to operate ▪ Strong funding support from government and favourable policy	**WEAKNESSES** ▪ Current land available is sufficient to handle existing quantum of waste, however if they have to expand, availability of land will limit large scale expansion ▪ Enterprise dependent on waste resource centres for segregation
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Developing different formulations of organic compost including pelletization of fecal sludge compost ▪ Municipal tax for non-segregators ▪ 2007 government act, enabling self-branding and obtaining waste management funds ▪ Replication of similar model for other towns in Sri Lanka ▪ Tapping carbon market as an additional revenue source	**THREATS** ▪ Subsidies on inorganic fertilizers represent competition and may impact sales of organic compost ▪ Cultural barriers – farmers unwillingness to use compost mixed with dry fecal matter

compost to meet farmers' requirements; c) with increased scale, BCP can consider tapping into the carbon market as an additional revenue source; and d) increasing government support for solid waste management has created a demand for this model which can be replicated in other towns and cities in Sri Lanka. A significant threat to BCP's business is increasing competition from subsidized chemical fertilizer which may affect the demand for their compost products.

Contributors

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Josiane Nikiema, IWMI, Ghana

References and further readings

Personal communication with Mr. Nimal Prematilaka (Officer in charge of Balangoda Compost Plant). 2015.

Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2015. As business operations are dynamic, data can be subject to change.

Notes

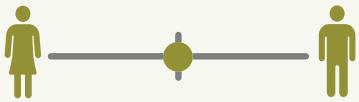
1 Night soil is a euphemism for human excrement, (formerly) collected at night from households. In our context, it refers to fecal sludge collected from on-site sanitation facilities, like septic tanks and pit latrines.
2 http://lirneasia.net (accessed November 8, 2017).

BUSINESS MODEL 10

Partially subsidized composting at district level

Munir A. Hanjra and Miriam Otoo

A. Key characteristics

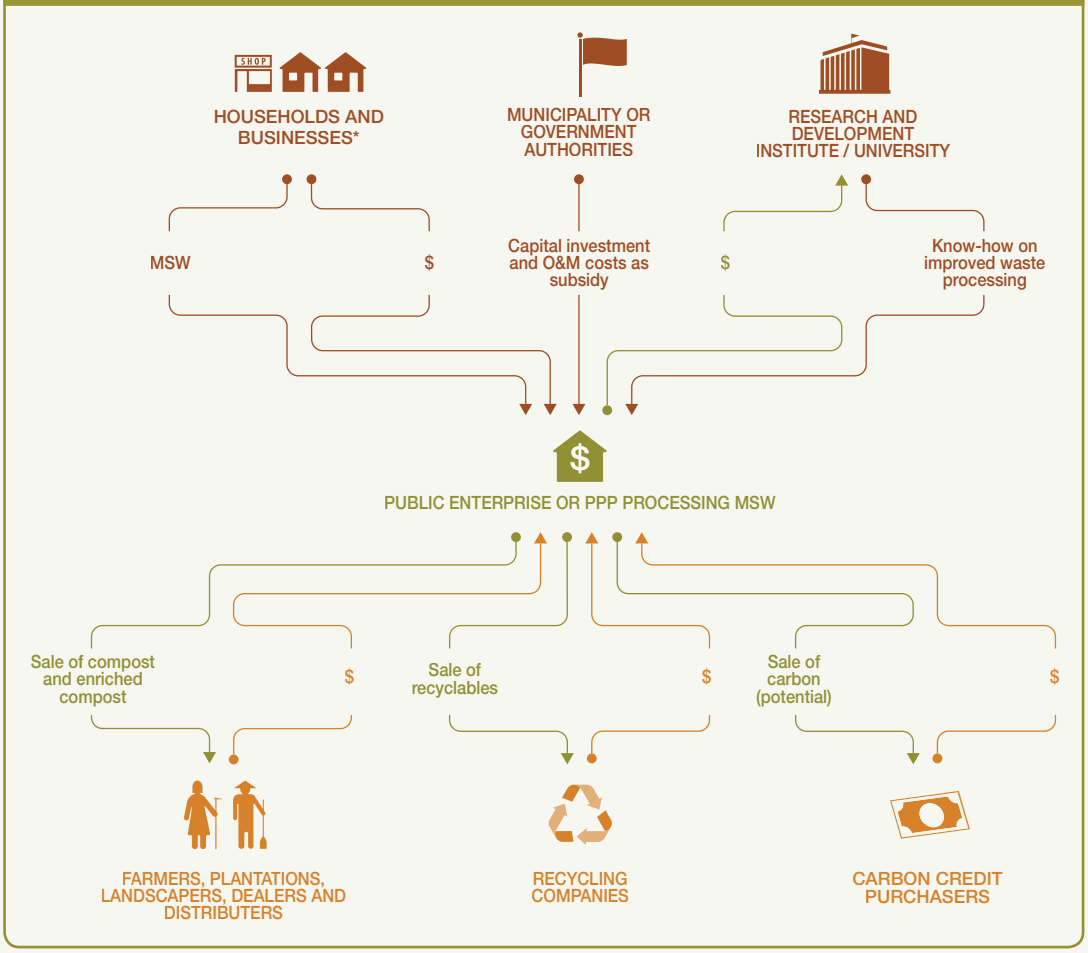
Model name	Partially subsidized composting at district level
Waste stream	Municipal solid waste (MSW) and fecal sludge
Value-added waste products	Regular compost, enriched compost, non-degradable recyclables, treated wastewater
Geography	Medium to large urban areas with large quantities of MSW, land availability and access to inexpensive labor
Scale of production	Small to medium, processes about 10–75 tons of MSW/day
Supporting cases in this book	Mbale, Uganda; Balangoda and Matara, Sri Lanka
Objective of entity	Cost-recovery [X]; For profit [ ]; Social enterprise [X]
Investment cost range	On average USD 250,000–370,000 depending on scale
Organization type	Public
Socio-economic impact	Disposal cost savings, new jobs, provision of compost and super compost to plantation farmers, treated water and cleaner environment
Gender equity	Model is fairly gender neutral; where women are engaged in waste segregation, they may earn additional income from sale of recyclables 

B. Business value chain

This business model can be initiated by a public entity or through a public-private partnership. The primary goal of the entity is to reduce open-dumping practices (maintain a clean city) and the quantity of waste landfilled, and resulting greenhouse gas emissions through the conversion of MSW and FS into compost. With investments justified based on the net positive environmental and socio-economic benefits, the municipality and/or government authorities often provide the capital investments (land, infrastructure, equipment, others) for the set-up of the compost plants as well as committing to providing continuous support for plant operation and maintenance. The publicly-run waste processing enterprise is often engaged across the entire value chain, i.e. involved in waste collection, segregation, processing, marketing and distribution of the compost. At the input side of the value chain, the public entity–municipality oftentimes owns the city's waste and thus has unlimited access to raw materials (MSW) and does not compete with any other company for the resources input. Collaborations with research institutes are recommended for the adoption of appropriate waste processing and compost production technologies.

This business model has the potential to transition from being subsidy-dependent to full cost-recovery and even profit-making. The efficient allocation of resources and engagement in activities where the business entity has a comparative advantage is critical for sustainability; and innovative partnerships are notable in having an important role to play in this regard. Opportunities for making profits can entice private entities to partner with the public entity and bring win-win outcomes for the stakeholders. In this regard, private sector financing becomes accessible and their strong capacities in product branding and marketing can be tapped into (Kaza et al., 2016). The public entity can sell the compost directly to agricultural producers through a segmented pricing approach to gain more revenue. However, distribution agents and agro-input suppliers/dealers are an efficient channel for accessing the fertilizer market especially if the public entity lacks capacity in marketing and distribution. The option of developing different formulations of compost tailored for specific crops, the sale of non-degradables such as plastics and metals to recycling firms and sale of carbon credits are alternative avenues to generate additional revenue, minimizing subsidy dependency and opportunity to move the model from cost-recovery to profit-maximization (Figure 131).

FIGURE 131. VALUE CHAIN SCHEMATIC – PARTIALLY SUBSIDIZED COMPOSTING AT DISTRICT LEVEL



Note: * Under a PPP it is optional if the public or private partner collects the waste.

C. Business model

The business model described here (Figure 132) presumes operation under a public entity with partial subsidies for governmental entities. The model has three value propositions: a) provide improved waste management services to households; b) increase access to environmentally sustainable organic fertilizer to agricultural producers at competitive market prices; and c) provide recycling companies with increased options for purchasing recyclables at competitive prices. Strategic partnership with governmental organizations assure access to capital investments but also recurrent financing for operations and maintenance (Kaza et al., 2016). The provision of waste collection services generates significant revenue for the public entity, received via government payments but also the waste tax they are able to charge to institutions and businesses who fail to segregate their waste. The latter can tremendously reduce segregation costs and speed up the entire compost production process which implies less operational costs and more benefits.

The production of organic fertilizers from MSW and FS imply that farmers have access to fertilizer options. The public entity can sell directly to the end-users and also utilize agricultural extension systems, input suppliers, private dealers or even existing chemical fertilizer distribution channels via partnerships. Implementing a segmented pricing approach, by charging a lower price for bulk sales and market price for retail purchases can increase revenue. By advocating for government incentives similar to those for chemical fertilizers, the compost can be sold to local farmers and farmer organizations at partially subsidized rates through government agencies and agricultural departments to gain a larger share of the fertilizer market. Also, value addition to the compost via fortification and pelletization and branding of the product could be instrumental for greater market penetration and revenue generation. A partnership with a research and development (R&D) institute becomes crucial as the public entity is able to tap into their research capacity to develop competitive compost products for a competitive fertilizer market. As a part of its marketing strategy and to expand its customer base, the public entity can give all its first-time customers free compost samples so that the farmers can see first-hand increased yields on their own farms. This can be instrumental in increasing its market share. An additional source of revenue is from the sale of recyclables which can be purchased from locals and sold directly to recycling companies at higher prices. For efficiency, the public entity can set-up decentralized waste resource centres where informal workers bring and sell the segregated recyclables to them. This value proposition in particular extends the model to be inclusive and provides indirect employment (income) to people that would otherwise be unemployed.

This model, although subsidy-dependent, generates significant environmental and socio-economic benefits that justify governmental support. Reduced open-dumping and burning of waste implies decreased GHG emissions and human exposure to untreated waste. The conversion of MSW and FS to compost is an avenue to improve soil productivity and agricultural yields, but also reduces waste disposal costs, GHG emissions from landfills and chemical fertilizer production. Opportunities to transition the model to financial independence is crucial in view of shrinking municipal budget allocations for waste management.

FIGURE 132. BUSINESS MODEL CANVAS – PARTIALLY SUBSIDIZED COMPOSTING AT DISTRICT LEVEL

KEY PARTNERS

- Municipality, city council
- Local university/ R&D institute
- Agro-dealers
- Waste resource centre

KEY ACTIVITIES

- Waste collection and segregation
- Production and sale of compost
- Shredding and pelletization
- Purchase and resale of recyclables

KEY RESOURCES

- Machinery
- Land and labor
- MSW
- Permit (composting and environmental impact assessment)
- Waste resource centres

VALUE PROPOSITIONS

- Provision of improved waste management services to households
- Farmers have increased access to alternative fertilizer products at a competitive price
- Recycling companies have access to recyclables products at an affordable price

CUSTOMER RELATIONSHIPS

- Waste collection through direct contact
- Personal help at direct sales
- Direct relationship

CHANNELS

- Direct
- Direct sales, word-of-mouth
- Direct sale

CUSTOMER SEGMENTS

- Households, commercial entities
- Agricultural producers (smallholder farmers, plantations, landscaping companies, local/ national agricultural departments)
- Recycling companies

COST STRUCTURE

- Capital investment costs (including receiving tanks, sedimentation tank, plastic and polythene pelletizer, water treatment facility and drying bed)
- Operation and maintenance costs (machinery, infrastructure, labor)
- Quality monitoring fee payment
- Cost of buying recyclables

REVENUE STREAMS

- Waste collection funds from government
- Waste tax from commercial entities that do not segregate waste
- Waste collection fees from commercial entities
- Government subsidy (partial)
- Sales of compost and other recyclables

SOCIAL AND ENVIRONMENTAL COSTS

- Possible pollution of water bodies from leachate
- Potential health and occupational safety risks to workers failing to wear protective gear
- Potential risk to the public where compost and segregation activities are in close proximity to neighbourhoods

SOCIAL AND ENVIRONMENTAL BENEFITS

- Reduced existing waste management costs
- Creation of job opportunities
- Reduction of environmental pollution from untreated waste
- Reduced human exposure to untreated waste
- Improved yield returns

D. Alternate scenarios

In the generic business model described above, a public entity converts MSW and FS to an organic fertilizer for sale to agricultural producers, provides waste collection services to households and resells recyclables at higher prices to commercial firms. This business model can incorporate alternative scenarios to enhance revenue generation and overall sustainability by: i) increasing its scale of operation (large scale) via a public-private partnership, and ii) revenue generation from carbon credits under the CDM.

Scenario I: Large-scale operation as a public-private partnership

Public entities can benefit from economies of scale to further reduce disposal costs and generate significant revenue through composting at a larger scale. This however requires increased capital investments for infrastructure as well as funds to cover operational and maintenance costs. Whilst municipalities are generally able to cover O&M costs, new capital investments can overstretch their budgets. Additionally, publicly-managed compost facilities often show inefficiencies in product innovation and marketing. Many of these shortcomings can be addressed by the business-oriented private sector seeking profits. Tapping into private sector capital and their capacity for management and innovation via public-private partnerships is essential for considerations of scaling-up and transitioning to full-cost recovery models. Public-private partnerships (PPPs) are a well-established means of providing infrastructure and services that public entities have neither the resources nor expertise to supply alone. Under the model described here, a PPP can become a win-win protocol where the public sector gets the opportunity to improve waste management services (waste collection, transportation and proper treatment or disposal) with collaborations from the private sector, while the private sector is given the opportunity to bring a waste business into existence as a profitable endeavour.

For large-scale composting operations, a suitable PPP arrangement could be where: a) the public sector constructs the infrastructure and provides the capital cost for equipment for composting; and b) private sector brings in operational capital and suitable management skills to operate the facility. Under the agreement, the private entity pays a monthly service fee to the public entity for using the already set-up composting infrastructure such as land, machines, composting facility. The public entity in turn collects the waste and pays tipping fees to the private entity for disposal and processing of the municipal solid waste. Under the management contract, the private business entity bears the cost of operation and maintenance. The PPP can establish satellite compost stations to produce compost at vintage points closer to local markets, to minimize transportation costs both for waste collection for the public entity and distribution of compost for the private business entity. This will allow them to sell compost at a flat rate exclusive of transport charges, while traders/retailers can add transportation cost and their own price mark-up to the final sale prices. In addition to compost, recyclables and fuel pellets can be sold to recycling companies and businesses, respectively to increase their revenues and achieve full-cost recovery/profits.

While the potential opportunities of the PPP model are increasingly clear, PPP contracts can be relatively more complicated than conventional procurement contracts. This is because oftentimes all possible contingencies that could arise in long-term contractual relationships are not anticipated beforehand. The sustainability of the model will thus depend on concessions and incentives such as (i) tax assignment and grants for segregation; (ii) advertisement rights for segregation at collection centres; (iii) unit cost payment for collection and transport; (iv) making land available for disposal; (v) buy-back of composting; (vi) tax holidays and other incentives; and (vii) carbon credits, being clearly outlined and agreed upon (ADB, 2011).

Scenario II: Carbon credits

The PPP model fits best where capital and management skills of a private entity can help fill capacity gaps of the public entity. Yet full-cost recovery in the PPP model may still remain elusive at least during the initial years, where economies of scale are not fully realized, and compost prices are still higher than that of subsidized chemical fertilizers. The sale of carbon credits can represent an alternative revenue stream, especially for PPP entities who are still unable to achieve financial break-even and dependent on government financial support. This business model typically requires partnerships/ engagements with the local government, national environmental management authorities, private entities and international partners. The application process for carbon credit sale can be lengthy and costly; and in view of volatile market prices, the net return should be taken into account prior to investing in the process.

E. Potential risks and mitigation

The business model presented here was designed and optimized based on the analysis of different case studies (see previous sections). In designing this optimized business model, risks related to safety, local acceptance by the community and business attractiveness for investors were assessed.

Market risks: Risks in the input market are very low as the public entity typically owns the city's waste or is granted exclusive rights by governmental authorities. On the output side, the main risk relates to competition in the 'larger' fertilizer market.

Competition risks: Competition as noted under 'market risks' stem from price distortions in the output market where the compost products compete with often subsidized chemical fertilizers. Product innovation to increase compost nutrient levels, branding via certification, free samples and field trials can help mitigate the negative effects of competition. Satellite composting stations in vantage points and close to its key customers can improve market penetration.

Technology performance risks: The composting technology traditionally used is windrow composting. Depending on the scale, components of the process (e.g. waste segregation) can be mechanized for efficiency. This however implies increased energy requirements which can be costly and if there are energy shortages represent a key challenge for performance. Additionally, the need for advanced-skilled labor represent increased operational costs. On the other hand, if more labor-intensive processes are used, then labor availability (including skills set) and related costs have to be taken into account.

Political and regulatory risks: It is important to note however that policies and regulations differ from country to country and so whilst reuse of fecal sludge may be permissible in Sri Lanka, it may not be allowed elsewhere. Thus, it is important that national and local guidelines and policies are adhered to. Specific to this model, there are low regulatory risks as the public entity will only engage in resource recovery initiatives that are permissible by law as they are financed by public funds. Thus, the plants' practices are very likely to follow the outlined national/local guidelines and policies on waste management activities, and compost product safety.

Social equity related risks: Consideration of the set-up of decentralized waste resource centres for recyclables may offer informal workers the opportunity to sell the segregated recyclables they collect to the plant. This value proposition in particular extends the model to be inclusive and provides indirect employment (income) to people that would otherwise be unemployed. On the other hand, however, improved waste collection, segregation and recycling may limit informal workers access to waste value chain and invariably, income.

Safety, environmental and health risks: The compost product should meet the minimum nutrient level requirements outlined in the respective national/local guidelines via regular quality monitoring. There are potential health risks to different actors along both the sanitation and agricutural value chains, associated with the collection, treatment, processing and use of human excreta (Table 35). In particular, workers that collect the fecal sludge and composted materials and consumers of food products grown with waste-based compost are the groups with the highest level of risk. The provision of protective gear for chamber-empyting operations should be mandatory. From the consumer perspective, microbial testing should be a routine measure for quality assurance of the compost product. Additionally, farmers must be trained on the appropriate application methods for the waste-based fertilizer products. Recommendations of national agriculture agencies must also be implemented in tandem, in association with agricultural extension agents.

TABLE 35. POTENTIAL HEALTH AND ENVIRONMENTAL RISKS AND SUGGESTED MITIGATION MEASURES FOR BUSINESS MODEL 10

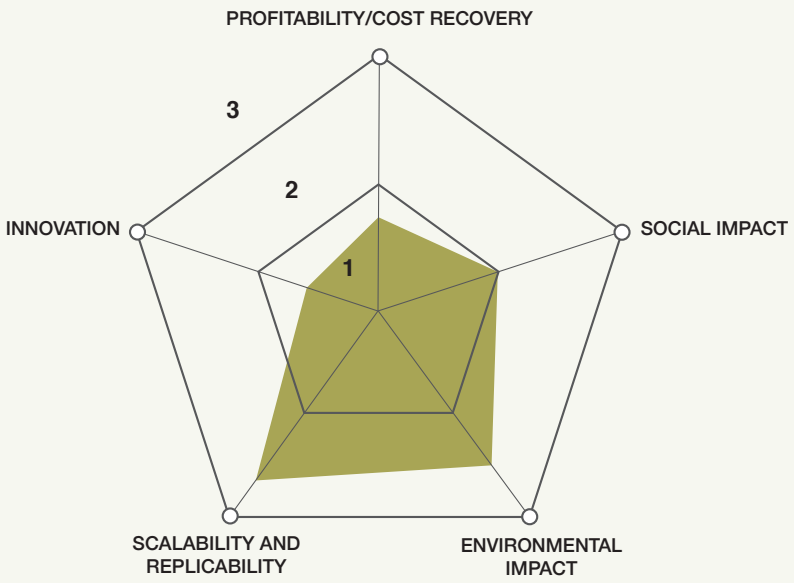
RISK GROUP	EXPOSURE					REMARKS
	DIRECT CONTACT	AIR/DUST	INSECTS	WATER/ SOIL	FOOD	
Worker						Risk of sharp objects in MSW and fecal contamination Potential risk of dust, noise and chemical compost contaminants
Farmer/user						
Community						
Consumer						
Mitigation Measures						

Key ☐ NOT APPLICABLE ▒ LOW RISK ▒ MEDIUM RISK ■ HIGH RISK

F. Business performance

The model ranks highest on scalability and replicability as it has a strong potential for implementation in medium and large cities (Figure 133). Depending on the scale of operations, adaptation to the technology and market development may be required. This model is ranked high on environmental and social impact partly due to the large quantities of waste collected and processed which results in reduced indiscriminate waste disposal, reduced human exposure to untreated waste, reduced GHG emissions from landfills and the opportunity for job creation. The inherent dependence on government for financial support makes the model rank very low on profitability. Although generally geared only towards partial cost recovery, the model has potential to transition into full-cost recovery and even profit-making under public-private partnership agreements. The low ranking of the innovation criteria is mainly attributable to the simplicity of the technologies.

FIGURE 133. RANKING RESULTS FOR PARTIALLY SUBSIDIZED COMPOSTING AT DISTRICT LEVEL BUSINESS MODEL



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8. BUSINESS MODELS ON SUBSIDY-FREE COMMUNITY-BASED COMPOSTING

Introduction

Towns and cities across the developing world continue to face the challenge of managing municipal solid waste (MSW). For smaller towns, the relatively easier availability of land for disposal of MSW and lower costs of transporting the waste to landfills oftentimes represent disincentives for MSW-based composting. However, many of these towns are rapidly transitioning into cities in view of exponential population growth and urbanization; and with limited public funds to support waste management infrastructure and services, there is a dire need to identify and adopt sustainable waste management measures that can handle the significant quantities of waste being generated.

Large-scale centralized composting whilst able to process big quantities of waste at a time tends to be highly mechanized and thus require hefty investments for advanced machineries, significant operation and maintenance costs and a high degree of specialized skills to operate and maintain the plants. Additionally, transportation costs can be substantial as all the waste needs to be transported to disposal facilities often located far from the city. The quality of compost tends to be poor due to the large quantities of unseparated waste with high risks of contamination. Thus, revenue generated from compost sales is often insufficient to cover the capital, operation and maintenance costs. With increasingly shrinking municipal budget for waste management, a large percentage of these compost plants have reached the end of their life cycle or in dire need of upgrade and maintenance. Sustainable funding mechanisms thus become a major factor in the success of national strategies for municipal solid management programs.

Decentralized composting systems offer several advantages over centralized large-scale systems and are increasingly been observed, particularly for secondary cities and small towns, and even large cities where the local government can allocate land. Adopting a labor-intensive, cheap and low technological approach, the business does not require a large capital investment (except for land purchase) or state-of the art machinery, which removes one of the major constraints for business start-ups especially in the developing world context. The decentralised composting approach reduces transportation costs and makes use of low cost technologies based on manual labor and ensures that waste is well-sorted before it is composted. This minimizes many of the problems and difficulties that have led to the failure of large centralized composting plants in the past. There is great potential for the upscaling of this model due to its simplicity. However, poor management and incentives to entities operating the decentralized units often results in poor quality compost (low market demand) and misappropriation of funds, which invariably causes the plant to fail. Studies have shown that whilst most decentralized composting businesses have a non-profit seeking model, these constraints limit cost-recovery and additional public funding is oftentimes required to bridge the financial gap.

Business models with inherently sustainable funding mechanisms (i.e. profit-making model), such as a **subsidy-free community-based** composting initiative, are necessary. As an example, a cooperative model approach to decentralized composting creates a greater incentive for community participation. There is a higher probability of success as benefiting communities are involved in waste collection, separation and composting, plant management and ownership. The sustainability of this model is grounded in strong partnerships and the assured benefits (profit-sharing) accruing to each partner. Voluntary participation via membership fee payments are indicative of the commitment of members and thus ensure success of the enterprise. Municipalities have an incentive to support communities in finding composting sites, developing a proper system for waste collection and disposal of residues, and providing land and funds for construction of composting plants as these initiatives alleviate them of the burden of solid waste management.

In this chapter, we present the business model and a case example that show the concept of subsidy-free community-based composting, and the notable potential it offers by organizing communities into a *cooperative.* The presented case study shows that subsidy-free community-based composting offers a solution for turning waste into wealth, but requires investments in social capital to organize and mobilize the communities.

CASE

Cooperative model for financially sustainable municipal solid waste composting (NAWACOM, Kenya)

Miriam Otoo, Nancy Karanja, Jack Odero and Lesley Hope

Supporting case for Business Model 11	
Location:	Nakuru, Kenya
Waste input type:	Municipal solid waste (including plants and animal waste)
Value offer:	Provision of a safe compost product as a soil conditioner
Organization type:	Cooperative
Status of organization:	Operational since 2002; plant operations had halted at time of last publication review (October 2017)
Scale of businesses:	Processes 28 tons of waste/ day
Major partners:	University of Nairobi, Egerton University, Practical Action, Comic Relief, National Agricultural Advisory Service, World Bank

Executive summary

The Nakuru Waste Collectors and Recyclers Management Cooperative Society (NAWACOM) is a cooperative that has brought together various community-based organizations (CBOs) in the organic waste recovery arena in Nakuru. Their main focus was to take up the waste management challenge in Nakuru town and create an avenue for income generation under the slogan 'turning waste to wealth'. CBOs initially operated as individual entities but transitioned into a cooperative to secure financial support from Comic Relief via Practical Action to scale up their operations. NAWACOM was then formed as the representative umbrella body. The CBOs produce a partially processed compost product from agricultural, household and market waste using a windrow composting technology, which is then sold to NAWACOM. The product is further composted, fortified, packaged and branded under the name Mazingira. The benefits of the decentralization of NAWACOM's activities has ensured that: a) smaller-scale CBOs are still able to financially sustain their businesses by not having to put up significant capital investment for equipment and establishing sound marketing and distribution channels; and b) NAWACOM allocates its resource efficiently – i.e. waste collection and separation is outsourced to communities, reducing high transportation costs. Ninety-five percent of the organic fertilizer is sold directly to farmers through word of mouth and the remaining percentage through agro-shops. Revenue streams of the cooperative are mainly from compost sales and member subscription fees. All accrued profits are shared among cooperative members. NAWACOM's activities have helped

to significantly reduce the city's waste management costs, reduce human exposure to untreated waste and contribute to the livelihoods of local communities.

KEY PERFORMANCE INDICATORS (AS OF 2015)						
Land use:	0.41 ha					
Capital investment:	USD 4,671 excluding land costs					
Labor:	6 (2 skilled part-time, 4 unskilled part-time) – excludes employees in the different CBOs					
O&M:	USD 9,977 per year					
Output:	100–300 tons of compost per season					
Potential social and/or enviornmental impact:	Creation of 6 part-time jobs, provison of a nutrient rich organic fertilizer for agricultural production and a clean environment					
Financial viability indicators:	Payback period:	5 years	Post Tax IRR:	N.A.	Gross margin:	40%

Context and background

Nakuru town is the fourth largest urban centre in Kenya. It is centred in rich agricultural hinterland with fertile volcanic soils and has an ever developing industrial and tourism industry. Rapid urban growth, which is estimated at 3.4% per annum over the last three years, has resulted in the development of unplanned residential areas and slums; hence garbage heaps are a common sight as the Municipal Council is over-stretched in offering services in solid waste management. To bridge the gap between waste generation and collection, NAWACOM, a cooperative society, in 2002 stepped in with the aim of providing sanitation services and environmental conservation whilst generating revenue. Community-based organizations involved in waste reuse initially operated as individual entities but transitioned into a cooperative to secure financial support from Comic Relief via Practical Action to scale up their operations. In 2006, NAWACOM was registered as a cooperative in accordance with Section 3 of the Cooperative Societies Act (Amended 2004) of the laws of Kenya. Technical support came from Practical Action Kenya, which is an international non-governmental organization while funding was provided by Comic Relief (a UK-based charitable organization). The objective of this partnership was to showcase how community members could contribute towards solid waste management in a sustainable way. The cooperative works by contracting its members (CBOs) to collect and compost organic waste from peri-urban areas of the town (mostly livestock and household waste from famers) and also private waste collectors who sort and compost waste from within the town. At the time of the assessment, membership stood at 94 people, with 55 women and 39 men. Membership recruitment was open to all provided each member shared in the cooperative's vision and was able to pay the annual membership subscription of USD 56.92 (Ksh 5000)[1].

Market environment

The negative effect from chemical fertilizer over-application on soils and water bodies has caused an upsurge in the demand for organic fertilizer use. Farmers have observed declining soil health and decreased crop yields over time, and recognize the need to adopt environmentally sustainable agricultural practices. Additionally, recommended agricultural practices, particularly for the production of exported food products, require the use of organic agricultural inputs. Furthermore, rapid urban population growth in Nakuru city has resulted in the development of unplanned residential areas and slums and subsequently generation of significant amounts of waste. The quantity of generated waste has overstretched the municipal council's budget for waste management. NAWACOM and its community members thus ceased this opportunity to fill in the gap for providing waste management and a safe organic fertilizer for the production of exportable goods.

Macro-economic environment

The Kenyan government highly subsidizes chemical fertilizers. The government's fertilizer subsidy programs began in 2008 with the aim to cushion farmers against seasonal changes in the price of fertilizer. By the end of the 2012/2013 financial year, over 400,000 metric tons of fertilizer, worth Ksh 13.80 billion had been distributed countrywide. The amount of subsidies on chemical fertilizer has grown exponentially in the last few decades and has been mainly attributed to inflation and price fluctuations in the international market. The government has plans to increase its fertilizer subsidy budget allocation to Ksh 15 billion over the next five years. With continued governmental support, chemical fertilizer prices will continue to be more competitive than organic fertilizer prices making it difficult for new businesses to enter the fertilizer market. With a growing need to increase the availability and quality of bio-fertilizers and composts in the country to improve agricultural productivity while maintaining soil health and environmental safety, Kenya will need to set up a scheme to augment the infrastructure for production of quality organic and biological inputs and some level of price subsidy to organic fertilizer producers to make them competitive on the market.

Business model

NAWACOM is a waste processing cooperative that uses household, animal and market waste to produce an organic fertilizer product – Mazingira, which is sold directly to small-scale farmers. As a cooperative, it contracts its members to collect and compost organic waste from peri-urban areas of the town. Essential in its business model is the decentralization of NAWACOM's activities. Members of the various CBOs compost the organic waste resources on their premises and deliver a partially composted product to NAWACOM, who then processes it further to maturation and fortifies it. This has ensured that: a) smaller-scale CBOs are still able to financially sustain their businesses by not having to put up significant capital investment for equipment and establishing sound marketing and distribution channels; and b) NAWACOM allocates its resource efficiently – i.e. waste collection and separation is outsourced to communities, reducing high transportation costs. The price of the partially processed compost, ranging from USD 0.05 to 0.07 per kg, is determined by its nitrogen content and level of pathogens, which are the indicators of quality. This pricing strategy helps NAWACOM maintain a high product quality standard as all members aim to receive the highest purchase price for their compost as possible per the market's willingness-to-pay. The cooperative is value-driven where quality of the product is the main focus. NAWACOM sells the final organic fertilizer product, Mazingira, mainly to small-scale farmers at USD 17.65 per 50kg bag. The cooperative markets their product via word-of-mouth which has proven to be an effective strategy given the high product quality. The cooperative also generates revenue from membership subscription fees at USD 59 per member per annum, which is used to cover operational costs and has ensured continuous operation of the business. The cooperative has nine staffs, of which six form an oversight committee. The remaining three are the executives who are also signatories to the account. NAWACOM instituted an oversight committee to prevent swindling of cooperative funds by the executives. The cooperative partnered with Comic relief and Practical Action Kenya for financial and technical support at the onset of the business. Egerton University and University of Nairobi are the main bodies in charge of the product quality analysis. The compost is fortified with Mijingu Phosphate Rock as a means of increasing the nutrient content and demanding a higher market price. Plans are underway to get a Kenya Bureau Standard Board (KEBS) certification, which will enable NAWACOM to penetrate the large-scale farmers' customer segment. The activities of NAWACOM have contributed to the reduction of cost associated with waste management whilst keeping the city clean. In addition, it has provided cooperative members with an additional income. See Figure 134 opposite for the diagrammatic overview of the business model.

FIGURE 134. NAWACOM'S BUSINESS MODEL CANVAS

KEY PARTNERS

- Agricultural input shops
- Egerton University
- University of Nairobi
- Comic Relief
- Practical Action
- Standard Board (KEBS)
- Municipal Council
- Cooperative members

KEY ACTIVITIES

- Coordinating delivery of partially processed compost by members
- Quality control of incoming compost
- Processing and fortification of compost
- Packaging
- Sale of compost
- Branding, marketing

KEY RESOURCES

- Household, market and animal waste
- Mijingu Phosphate Rock
- Laborers
- Licensing
- Brand name Mazingira

VALUE PROPOSITIONS

- Local farmers obtain a quality-checked, organic fertilizers of high nutrient level at a competitive price

CUSTOMER RELATIONSHIPS

- Personal help at direct sales

CHANNELS

- Direct sales via word-of-mouth (95%)
- Agro-input shops (5%)

CUSTOMER SEGMENTS

- Small-scale farmers

COST STRUCTURE

- Capital investment (land, machinery, licensing)
- Operation and maintenance (labor cost (6 part-time), electricity, land rent, maintenance costs)
- Quality control fees (University of Egerton and Nairobi University laboratories)
- Administrative costs (collection of member fees and selling the compost)
- Transport costs savings

REVENUE STREAMS

- Sales of compost (75%)
- Membership subscription fees (25%)

SOCIAL & ENVIRONMENTAL COSTS

- Manual execution of activities such as sieving and packaging may be a source of occupational health risk

SOCIAL & ENVIRONMENTAL BENEFITS

- Reduced existing waste management costs
- Reduced human exposure to untreated waste
- Creation of jobs (6 part-time jobs)
- Improved food security
- Increase in income for low-income population
- Government savings from reduced importation of inorganic fertilizers
- Community empowerment by means of a cooperative

Value chain and position

NAWACOM is a waste processing cooperative that produces organic fertilizer from MSW. The cooperative's activities are the production, marketing and sale of fortified compost (Figure 135). NAWACOM sources its raw materials (partially processed compost) from its members (CBOs) and is their sole client. Market and household waste are the main waste streams used for the composting activities of the CBOs. Given that NAWACOM as a business entity does not directly source for MSW for processing activities, it faces very low input supply risk. Additionally, MSW is an abundant resource especially in the peri-urban areas, markets and high-density inner city with currently limited alternative use. NAWACOM purchases the partially processed compost from its members at a fee (dependent on nitrogen concentration and pathogen levels) and further processes and fortifies with Mijingu Phosphate Rock. The final product is sold directly to small-scale farmers. Although NAWACOM partners with the University of Egerton and Nairobi University for the fee-based quality analysis of their product, the cooperative's failure to obtain KEBS certification has limited its ability to penetrate new markets. Other organic fertilizers and chemical fertilizers are good substitutes for NAWACOM's organic fertilizer. Additionally, chemical fertilizer is high in demand due its ease of application, high NPK levels and KEBS certification. In 2012, NAWACOM received an order for 500 tons of compost to be supplied over the entire year from a major agricultural input supplier. It was however unable to meet the demand as it is illegal to supply large quantities of compost to agricultural input suppliers with the seal of KEBS. NAWACOM faces fierce competition in the fertilizer market but the acquisition of KEBS certification will increase product demand and ease its penetration into larger customer segments, beyond the about 3,000 farmers it serves per year.

FIGURE 135. NAWACOM'S VALUE CHAIN

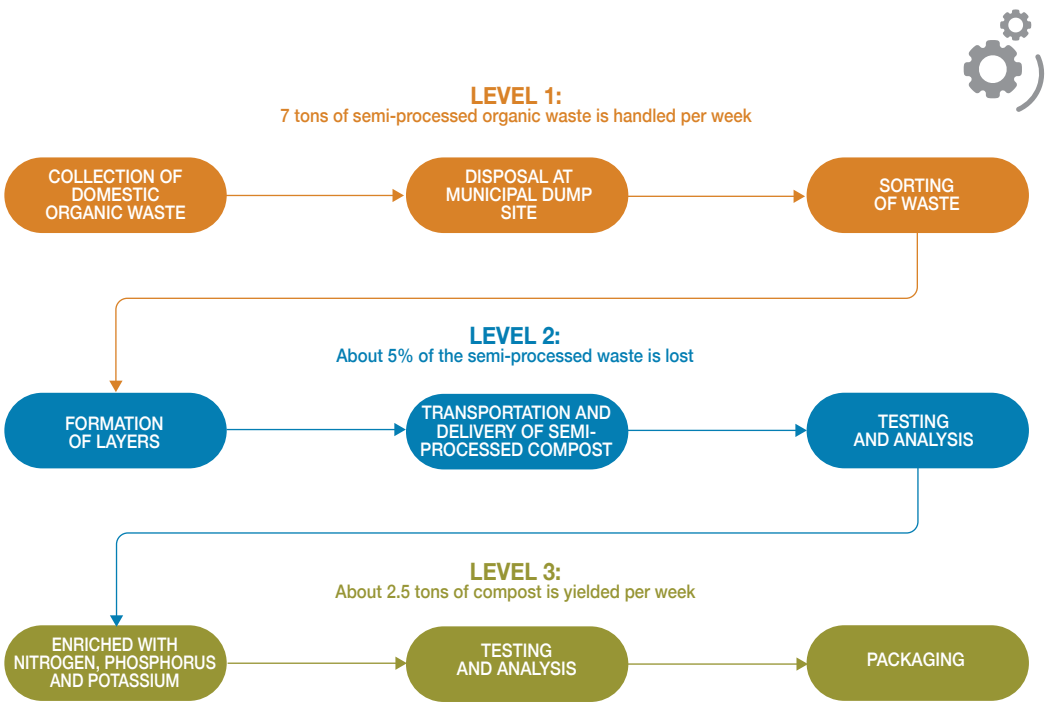
Institutional environment

Management of solid waste in Kenya is dealt with under several laws, by-laws, regulations and acts of parliament. Some of them include the Environmental Management and Coordination Act (EMCA) of 1999 and City Council (solid waste management) by-law of 2007 which requires waste reuse businesses assure the safety of all actors involved in the business operations and the quality of the product. To legally engage in composting activities in Kenya, a waste management permit from the City Council (at USD 200 per year) and NEMA (at USD 471 per year) are a requirement and are renewable on a yearly basis. The Kenya Bureau Standard Board (KEBS) is mandated to certify organic products for sales in the country. Compliance to product quality guidelines for compost is largely unregulated in Kenya although KEBS has developed standards and guidelines to meet demand in the country for marketing of organic fertilizer products. Organic fertilizer produced by NAWACOM has yet to meet the standards set by KEBS and this has limited NAWACOM's access into certain market segments.

Technology and processes

NAWACOM works on a contractual basis where suppliers, both members and non-members (although members are given the priority), collect, sort and compost organic waste in their homes for four to six weeks. Windrow composting is the technology used. This technology, although labor-intensive, requires low capital investment and has high rates of resource recovery (Figure 136). The technology however requires significant amounts of space which can be a challenge for small-scale CBOs. It is in this regard, that the CBOs partially compost the organic waste at their own premises and deliver it to NAWACOM's main processing site for maturation and quality check. Once the compost has fully matured, samples are taken to Kenya Agricultural Research Institute (KARI) and Egerton University

FIGURE 136. PROCESS DIAGRAM FOR PRODUCTION OF NAWACOM'S COMPOST



for quality analysis, mainly to ascertain nitrogen concentration, and pathogen and heavy metal levels. The compost is then transported back to the cooperative's operations site where it is sieved to a finer particle size. The end product (fine compost) is fortified with Minjingu Phosphate Rock and other natural materials to increase its potassium and phosphorus levels to attain an NPK ratio of 2:1.5:1.8. Products are then packaged into 25 and 50kg bags. NAWACOM implements strong internal regulations, ensuring that all persons involved in the compost production process wear protective gear at all times.

Funding and financial outlook

Initial investment for NAWACOM as a community-based organization came from membership subscription, which amounted to USD 3,529 per year. This was barely sufficient to purchase the partially processed compost that NAWACOM further added value to, thus production and operations were low until 2006 when Comic Relief came in to provide financial support. The provision of financial support (USD 47,000) was on condition that the umbrella body – NAWACOM – be registered and operate as a cooperative. The investment provided covered costs of machinery, inputs (partial compost) and licensing. Operation and maintenance cost is estimated at USD 9,976/year and includes costs of labor (six part-time), electricity, land rent and other associated repairs and maintenance costs. The revenue streams of NAWACOM are sales of compost (75%) and membership subscription fees (25%). Compost is a seasonal product and sold in the two agricultural seasons in the year. NAWACOM sells between 3,000–6,000 50kg bags retailing at USD 17.65/bag. This translates into gross revenue of USD 52,000 to USD 105,000 per year. The cooperative has 94 members and the membership fees yield a revenue of USD 5,527 per annum at a rate of USD 58.8 per membership fee per person per year. NAWACOM has been generating profit since the exit of Comic Relief in 2008, indicating that with increased production and demand, the cooperative stands to accrue high profits/benefits to its shareholders.

Socio-economic, health and environmental impact

Economic gains of NAWACOM's activities include environmental, social and human health benefits. Although no absolute figures were provided, environmental benefits can be traced to reduction of pollution due to reduced human exposure to untreated waste and contamination of water bodies from open dumping. NAWACOM has increased the income of considerable number of people through employment and the sales of semi-composted organic waste. The increase in income for these people represents increased purchasing power, which can be translated into improved food security. The cooperative's activities have also had a positive impact on the government budgets as waste collection is done free of charge. An important risk to bear in mind is that related to the manual sieving and packaging of the compost, which may represent a source of occupational health risk if mitigation measures such as wearing of nose mask and gloves are not adhered to.

Scalability and replicability considerations

The key factors driving the success of this business are:

- Farmers have observed declining soil health and decreased crop yields over time and recognize the need to adopt environmentally sustainable agricultural practices.
- Assured high quality product sold at a competitive market price.
- Strong relationships and win-win partnership with its members.
- Innovative pricing strategy for input (partially processed compost) ensuring high quality product.
- Traditional word-of-mouth marketing strategy has proven to be a successful strategy given the assured quality of their product.
- Establishment of an oversight committee has been essential in curbing the misappropriation of cooperative funds.
- Strong commitment of members to the vision of the cooperative.

This model has a high potential of being replicated in developing countries where community involvement in waste management is encouraged. This case is unique in that it is a cooperative that has contracted its members to partially compost household, animal and market waste. The monetary benefits accruing to all parties create an incentive for commitment and success of the business. This model can easily be replicated as the start-up capital is fairly low and the technology is simple and capitalizing on the abundance of labor, requires a lot of land depending on scale. With rapid urbanization, rental and sale prices of land in both urban and peri-urban areas in developing cities have skyrocketed and this may represent a major constraint. Additionally, cooperatives have a history of high failure rates especially in developing countries. Stringent and efficient measure need to be put in place to ensure its success.

Summary assessment – SWOT analysis

NAWACOM represents an initiative of a group of CBOs who successfully sustained their business following the exit of donor funding. The cooperative has been particularly successful by implementing an oversight committee, which has been essential in the smooth running of business operations. Assured high quality and affordability of Mazingira fertilizer has been instrumental for NAWACOM in increasing its market demand and exploring other market segments (Figure 137). The decentralization

FIGURE 137. SWOT ANALYSIS – NAWACOM

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ High nutrient level organic fertilizer ▪ High up-scaling potential ▪ Low cost of technology ▪ Availability and easy access to waste and production inputs (partially processed compost) ▪ Self-branding has increased market share ▪ Fortification has increased product marketability	**WEAKNESSES** ▪ Financial instability ▪ High transportation cost ▪ Non-government-certified product
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Production of animal feed ▪ Potential to produce granulated compost and access new markets ▪ Increase in the scope of market from product certification ▪ Acquiring KEBS certification increases market and revenues per unit	**THREATS** ▪ High rental prices of land ▪ Attitudinal problem – farmers see organic fertilizer as secondary input ▪ Lack of certification from KEBS may disrupt business activity ▪ Absent scheme for the promotion of organic materials vis-à-vis continued heavy subsidization of chemical fertilizers limits growth. ▪ With continued governmental support, chemical fertilizer prices will continue to be more competitive than organic fertilizer

of NAWACOM's activities has ensured that: a) smaller-scale CBOs are still able to financially sustain their businesses by not having to put up significant capital investment for equipment and establishing sound marketing and distribution channels; and b) NAWACOM allocates its resource efficiently – i.e. waste collection and separation is outsourced to communities, reducing high transportation costs. The organic fertilizer produced by NAWACOM has not yet been approved by KEBS and this has limited its access to different and larger market segments. It is so far only serving about 3000 small-scale farmers per year, which is less than 2% of the market. A certification by KEBS and pelletization/granulation of its product will enable it to penetrate new market segments. Increasing governmental support along with growing demand for organic fertilizers will represent key opportunities for replication and up-scaling of the business.

Contributors

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Johannes Heeb, CEWAS, Switzerland
Josiane Nikiema, IWMI, Ghana

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Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2015. As business operations are dynamic data can be subject to change. Plant operations were noted to have halted at time of latest edit (October 2017).

Note

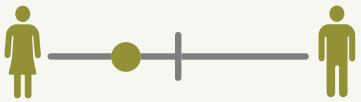
1 Ksh is Kenyan shillings. 2015 Exchange rate: USD 1 = Ksh 87.85.

BUSINESS MODEL 11

Subsidy-free community-based composting

Miriam Otoo and Munir A. Hanjra

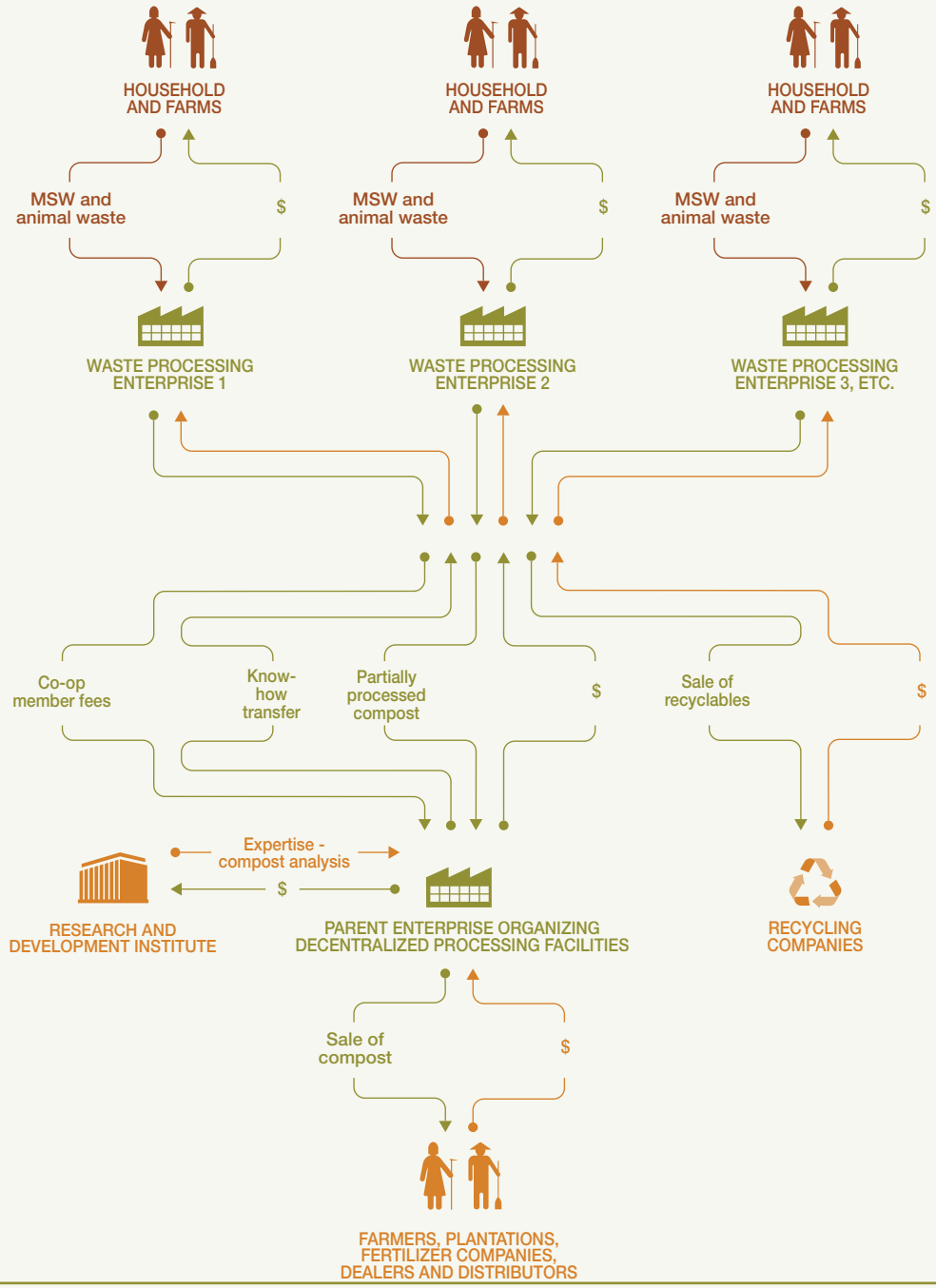
A. Key characteristics

Model name	Subsidy-free community-based composting
Waste stream	Municipal solid waste (including plant and animal waste)
Value-added Waste product	Provision of waste management services to communities, and provision of an affordable and safe compost for soil conditioning
Geography	Replicable in medium and large cities where land availability is limited; abundance and inexpensive labor
Scale of production	Small to medium, 20–30 tons of waste processed per day
Supporting cases in this book	Nakuru, Kenya
Objective of entity	Cost-recovery [X]; For profit [X]; Social enterprise [X]
Investment cost range	Capital cost about USD 3,500–5,500 excluding land costs, and O&M cost USD 7,50 –12,500 per year
Organization type	Cooperative
Socio-economic impact	Improved waste management service, creation of new jobs, provision of organic fertilizers for agriculture, improved soil productivity and a cleaner environment
Gender equity	Pro-gender model. Community based job opportunities for women 

B. Business value chain

Community-based composting models have shown some success but can be limited by poor management, limited access to financing due to investors' reluctance in funding smaller-scale initiatives. The community-based cooperative model however offers opportunities to address these limitations as small communities are able to mobilize their own resources by encouraging members to join the cooperative on voluntary basis and raise their own funding through membership fees. This business model is initiated by a cooperative – a distinct form of enterprise that provides services and/or products to the members, by the members, and for the members at a cost and divides the profits, known as surpluses in a cooperative, among the members pro rata to the amount of business each member did with the cooperative (Figure 138). Community-based organizations (decentralized composting facilities) form the consortium of the cooperative. Membership is voluntary and based on mutual social, cultural and economic needs – waste management and composting in this case. Whilst this could be a cost recovery model of decentralized composting operations at individual member's level, the cooperative element transitions this model into a profit-making model.

FIGURE 138. VALUE CHAIN SCHEMATIC – SUBSIDY-FREE COMMUNITY-BASED COMPOSTING



The CBOs collects waste from households and farms at a fee. Waste separation and its partial composting is done at the premises of each member, although depending on the scale for example, the local government may provide only land and infrastructure for plant operation. Outsourcing waste collection and separation implies land and transport cost savings to the parent enterprise that organizes the CBOs into a cooperative. The partially processed compost is sold to the parent enterprise. The members are incentivized to ensure high quality of the partially processed compost if the price they receive is dependent on product quality. The CBOs additionally generate revenue from the sale of recyclables. The parent enterprise that organizes the CBOs into a cooperative provide technical know-how to its members' composting. The parent enterprise can add value to the partially processed compost received from the CBOs by processing it further (i.e. fortification with nutrient minerals, pelletization), packaging, branding, marketing and distributing the final product. The outsourcing of specific activities to the CBOs by the parent enterprise ensures that an efficient allocation and use of resources. The parent enterprise generates revenue via membership fees and the sale of compost.

The unique features of this business model are: a) no recurrent governmental subsidies are required; b) assured monetary benefits accruing to all economic actors create incentives that underpin success; c) members of the cooperative circumvent the need for high capital investments for purchasing advanced equipment by producing a partially processed compost; d) by outsourcing waste collection, separation and partially composting the parent company reduces its operational costs and need for space, whilst on the other hand, CBOs have an assured market (parent enterprise) for their product; e) product quality and price dependency ensures a high quality product.

C. Business model

The basic value proposition of the model depends on the enterprise initiating the business model. Since this model can be initiated by a cooperative, unique value propositions that underpin this model are the ideals of cooperative movement – providing services for the members, by the members and to the members at cost and sharing the benefits. In that regard, the constituting value propositions are: a) provision of sustainable waste management services to communities; and b) increasing access to an affordable organic fertilizer to agricultural producers. The business model described here is from the perspective of a standalone private enterprise, operating as a cooperative (parent enterprise organizing the CBOs into a cooperative). Cooperative membership is open to all, provided that each member shares in the cooperative's vision and pays their annual membership and subscription fee. CBOs which form the core of the cooperative are contracted out for waste collection, separation and production of a partially processed compost, which is sold to the parent enterprise at a quality-determined price. A key partnership with a research institute is essential in developing a final compost product that is competitive on the fertilizer market. Third party product certification can help garner significant market demand and mitigate market competition effects from the often subsidized chemical fertilizer. The partially processed compost is further processed, packaged, branded and sold to farmers, fertilizer companies, dealers and distributors. The cooperative generates revenue from membership fees and compost sales.

The following elements aggregately ensure the success of this model: a) assured benefits to CBOs ensures commitment, output delivery and success of the cooperative; b) decentralized activities reduce transportation and land/ space costs; c) community involvement reduces waste segregation costs as they have a buy-in and awareness programs are more effective; d) CBOs are able to generate their own capital investment (which is modest given the decentralized nature and scale of operations); e) quality-determined pricing ensures a high quality product and invariably a greater market demand. This is a model that is not only financially self-sustaining (no recurrent governmental support) but also profitable, accruing significant benefits to society. This model can be extended to under-serviced areas such as new settlements and slums, under the scenario where community involvement can be

encouraged and depending on scale of operations, land/ space provided by the municipalities to the CBOs. See Figure 139 below for the diagrammatic overview of the business model.

D. Potential risks and mitigation

The business model presented here was designed and optimized based on the analysis of the NAWACOM case (see previous section). In designing this optimized business model, risks related to safety, local acceptance by the community, and business attractiveness for investors were assessed.

FIGURE 139. BUSINESS MODEL CANVAS – SUBSIDY-FREE COMMUNITY-BASED COMPOSTING

KEY PARTNERS

- University and research institute
- Financiers
- Municipal Council
- CBOs forming the cooperative

KEY ACTIVITIES

- Contract members to collect and compost waste
- Coordinate delivery of partially processed compost by members
- Pricing and quality control of semi-processed compost
- Processing and fortification of compost
- Marketing and distribution of final compost product
- Sharing of profits among members of the cooperative

KEY RESOURCES

- Cooperative societies Act
- Semi-processed compost
- Social capital among members
- Minerals for compost fortification
- Laborers
- Licensing, brand name

VALUE PROPOSITIONS

- Provision of waste management services to communities
- Agricultural producers and input retailers obtain an organic fertilizer at a competitive price

CUSTOMER RELATIONSHIPS

- Serviced by direct, personal help
- Personal help at direct sales

CHANNELS

- Direct sales via word-of-mouth
- Agro-input shops

CUSTOMER SEGMENTS

- Households
- Small-scale farmers, fertilizer companies, dealers and distributors

COST STRUCTURE

- Fee based quality analysis
- Capital investment (land, machinery, licensing)
- Operation and maintenance (electricity, land rent, maintenance costs)
- Quality control fees payment to university and research institute
- Administrative costs (collection of member fees and selling the compost)

REVENUE STREAMS

- Sales of compost
- Membership subscription fees

SOCIAL & ENVIRONMENTAL COSTS

- Dispersed and decentralized processing poses greater health risk to members and neighbours
- Manual execution of activities such as sieving and packaging may be a source of occupational health risk

SOCIAL & ENVIRONMENTAL BENEFITS

- Model to collect waste free of charge
- Reduces existing waste management costs
- Reduces human exposure to untreated waste
- Creates jobs
- Income for low-income population
- Increased access to fertilizer alternatives for farmers
- Government savings from reduced expenditure on waste management
- Community empowerment by means of cooperative principles and sharing of profits among members

General risks*:* Lack of community awareness and interest. There is a need for a reliable leader among the community, which is a pre-requisite to prevent falling into the trap of a 'failed cooperative'. The management structure can be fairly complex and this can affect the sustainability of the enterprise.

Market risks: The model has a very low input supply risk as supply is assured from its members. On the other hand, there are potential risks in the output market and this can arise from policy instruments such as chemical fertilizer subsidies. Additionally, the scale of operations (if small) can imply that the cooperative cannot target large-scale agro-producers who often have large orders. Product certification and branding is imperative to permit greater market penetration.

Competition risks: Key market competition (fertilizer market) as noted above arises due to policy instruments that make substitute products more affordable to farmers than compost.

Technology performance risks: The composting technology typically used (windrow composting) is a relatively mature and simple technology. It can be more labor-intensive and less mechanized which implies that factors such as equipment breakdown, maintenance and repair costs will have a limiting effect on technology perforamance. Members' quest to reduce waste segregation costs and improve the quality of the partially processed compost can result in them being selective of the types of waste they collect, and thus reducing the waste collection coverage in the communities (and increased burning of waste).

Political and regulatory risks: Cooperative models, particularly in developing countries, have shown a mixed record of success even in cases where community involvement and support have been strong.

This has been mainly attributed to poor management. Moral hazard issues often arise, for instance, due to the misuse of funds (sometimes attributable to lack of financial management skills and due diligence) by the executives and influential members. Effects of these issues can however be mitigated via the establishment of an oversight committee (with cooperative members required as signatories in addition to the executives), regular audits, disclosure of financial performance to all the members. Policies and regulations related to waste-based compost sectors differ by country. The oftentimes stronger political support for chemical fertilizer use (slow phasing-out of fertilizer subsidies) and lack of specific government guidelines for the certification of compost and internationally accredited third-party certification entities can represent a significant risk to the sustainability of the business model.

Social equity related risks: There are no distinctive social inequity risks associated with this model. In contrast, the model generates opportunities for increased benefits to women as they are culturally noted to collectively engage in small-scale waste segregation and recycling initiatives. The model supports employment opportunites and additional revenue, suited particularly for the women.

Safety, environmental and health risks: Whilst the simplicity and labor-intensiveness of the technology implies low-level skills and greater job opportunities for the informal workers and people who would otherwise be unemployed, there is a higher risk of worker exposure to waste and related pathogens if the approapriate gear is not used. Additionally, given that the pre-composting process is dispersed and occurs in multiple locations, there may be a larger number of people exposed to waste-related pathogens, depending on their level of training on safety measures and use of safety gear. Similarly, manual execution of activities such as sieving and packaging could be a source of occupational health risk. Trainings on occupational health risk mitigation is imperative for all members of the cooperative, particularly the CBOs. To address the safety and health risks to workers, standard protection measures are also required as elaborated below in Table 36.

TABLE 36. POTENTIAL HEALTH AND ENVIRONMENTAL RISK AND SUGGESTED MITIGATION MEASURES FOR BUSINESS MODEL 11

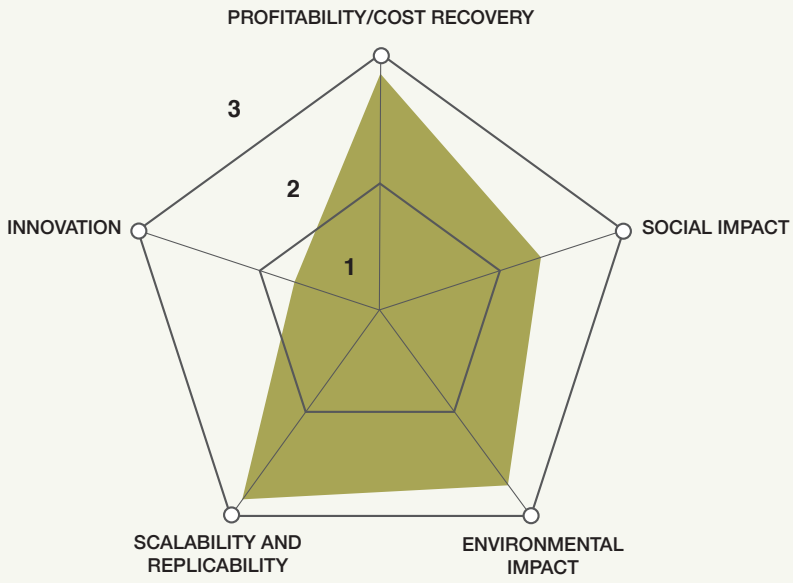
RISK GROUP	EXPOSURE					REMARKS
	DIRECT CONTACT	AIR/DUST	INSECTS	WATER/ SOIL	FOOD	
Worker						Risk of sharp objects in MSW and fecal contamination Potential risk of dust, noise and chemical compost contaminants
Farmer/user						
Community						
Consumer						
Mitigation measures						

Key: NOT APPLICABLE; LOW RISK; MEDIUM RISK; HIGH RISK

E. Business performance

This model is ranked highest on profitability due to the cooperative and cost-saving nature of the decentralized operations that produce a partially-processed compost product (Figure 140). The supplementary value-addition to the product via fortification and branding can represent an incremental price mark-up of the final compost product. The model also ranks high on scalability and replicability. This is because of the simplicity of the technology (low-level skill requirements), low capital costs requirements, relatively lower operational and maintenance costs and profits generated makes it attractive for communities with a cooperative vision to adopt and implement. Social impact and environmental impact rank next, whilst innovation is ranked the lowest which is attributable to the simplicity of the technologies and the word-of-mouth marketing strategy used.

FIGURE 140. RANKING RESULTS FOR THE SUBSIDY-FREE COMMUNITY-BASED COMPOSTING BUSINESS MODEL



9. BUSINESS MODELS ON LARGE-SCALE COMPOSTING FOR REVENUE GENERATION

Introduction

Nutrient recovery from waste initiatives primarily aim to address the waste management challenge, and oftentimes geared towards only partial cost recovery, rarely full-cost recovery or profit maximization. Continuous dependence on external financial support from government grants, subsidies, tax credits and rebates is unsustainable, particularly in view of the ever-diminishing public budget allocations to waste management. Looking beyond cost recovery and aiming for profit-making models is imperative if sustainable financial and economic returns on investments are expected.

Multiple revenue generation streams (i.e. portfolio diversification) represents additional avenues for businesses to become financially viable. This business approach offers a way for businesses to mitigate risk associated with limited/seasonal market demand of certain services and products. A clear example is that of compost with highest demand around the planting season. Seasonal demand implies increased storage costs for compost plants with all year-round production. Additionally, oftentimes given the strong competition in the fertilizer market, compost demand may be low and not generate enough funds sufficient to cover the plant's operational and maintenance costs. In this instance, it will be important for the business to tap into other revenue streams with more stable returns such as sale of recyclables and energy (electricity). Under this model, the multiple-revenue stream approach translates into several value propositions that generate even greater benefits to actors in the sanitation and agricultural sectors. We consider the following value propositions: a) improved waste management services to communities and businesses; b) provision of an environmentally-friendly organic fertilizer at competitive market prices to agricultural producers; c) increased access to input resources for recycling companies; d) increased energy availability to communities and businesses; e) provision of tradable certified emission reduction to meet carbon emission commitments.

The ability for businesses to successfully implement the above value propositions and capture the greatest economic benefits will partly depend on **scale** and **strategic partnerships**. While the composting concept is applicable across scale, large-scale composting offers greater opportunities for capturing economies of scale benefits, revenue generation and market proliferation. Large-scale composting can generate significant environmental and socio-economic benefits as it offers an opportunity for municipalities to manage massive quantities of solid waste generated and collected in the cities. The scale element of the model presents an option to significantly reduce waste quantities transported to landfills (final disposal sites), thus reducing waste management costs. Large-scale operations can also offer access into markets that smaller-scale facilities are often excluded from. In considering the energy sector, for example, waste reuse facilities have to operate at a certain scale (large-scale) to meet the minimum wattage requirements for sale to the grid. This is also applicable to the sale of carbon credits to UNFCCC Annex I countries[1]. Studies show that 98% of all registered Clean Development Mechanism (CDM) composting projects fall in the category of medium- to large-scale composting plants (Fenhann, 2012). The need for strategic partnerships extends beyond those with NGOs for development of CDM projects, compost marketers and dealers to increase market share to include municipal authorities for exclusive rights/access to waste streams, research institutes for product and technology innovation, and informal workers for increased access to slums and waste segregation efficiency.

While a great potential exists for business viability (profitability) and significant accrual of economic benefits to other actors in the agricultural and sanitation value chains, the implementation of the noted value propositions does not come without challenges and risks. Price volatility in carbon credit market, strong buyer power (monopoly) in the electricity market and price distortions in the fertilizer market from policy instruments (subsidies) are among a few of the key factors to be taken into consideration and whose effects need to be mitigated.

This chapter describes the generic **large-scale composting for revenue generation** model and five supporting case examples. The presented examples are not exhaustive and some better cases could have been inadvertently omitted due to information and time constraints but cover a wide range of easily accessible cases at scales ranging from medium to large scale operations in selected settings in Bangladesh and India. It is interesting to note that whilst large-scale composting is a growing concept in Africa, particularly Sub-Saharan Africa – this model is more established in the Asian context.

References and further readings

Fenhann, J. 2012. CDM pipeline overview. UNEP DTU Partnership: www.cdmpipeline.org/ (accessed 19 August, 2016).

Note

1 Industrialized or transitional economies as listed in Annex I of the United Nations Framework Convention on Climate Change (UNFCCC). http://unfccc.int/parties_and_observers/parties/annex_i/items/2774.php (accessed November 8, 2017).

CASE

Inclusive, public-private partnership-based municipal solid waste composting for profit (A2Z Infrastructure Limited, India)

Miriam Otoo, Joginder Singh, Lesley Hope and Priyanie Amerasinghe

Supporting case for Business Model 12	
Location:	Ludhiana, India
Waste input type:	Municipal solid waste (MSW), High density inorganic material
Value offer:	Provision of waste management services, high quality compost and renewable energy
Organization type:	Private (with several public-private partnership projects)
Status of organization:	Operational since 2011
Scale of businesses:	900 tons of municipal solid waste / day
Major partners:	Ludhiana Municipal Corporation, Indian Potash Limited, Indian Farmers Fertilizer Corporation Limited, Krishak Bharti Cooperative Limited

Executive summary

A2Z Infrastructure Private Limited (A2Z-PL), established in 2011, is a subsidiary business of the A2Z Group – one of India's leading waste management companies. With a core mandate to provide sustainable waste management solutions to municipalities across India, A2Z-PL operated at the time of the assessment 21 integrated resource recovery facilities (IRRF) across India, processing in total 8,000 tons of municipal solid waste (MSW) per day. One of such projects, which has shown significant success is the 900-ton IRRF in Ludhiana, Punjab. With a partnership agreement with the Ludhiana Municipal Corporation (LMC), A2Z-PL is contracted to collect, transport, process and dispose the MSW in five jurisdictional zones in Ludhiana. Their activities have so far had an immense impact in addressing the health and environmental problems associated with the open dumping of waste. A2Z-PL's success is based on a solid business model grounded in five principles: 1) self-sustainability via a multi-revenue stream approach; 2) using an integrated and inclusive approach via synergies in business operational activities and a public-private partnership (PPP); 3) zero tolerance for compromise of product quality; 4) maximum resource derivation; and 5) strict compliance to regulations. The Ludhiana business generated an annual net profit of 25–30 million Indian Rupees[1] (Rs.) in 2012. This mainly came from the sale of recovered resources – compost, high density plastics and metals as the total cost of waste collection, provision of bins, transportation and processing is

equivalent to the revenue made from the provision of such services at Rs.395 per ton, a cost borne by the municipality. With a business model that cuts across the entire MSW value chain, the Ludhiana business employs about 300 people of which 70% are unskilled laborers. This has improved the livelihoods of landfill ragpickers by ushering them into mainstream jobs. The actitivies of the Ludhiana IRRF have substantially reduced human direct exposure to waste, reduced the municipality's waste management costs and saved several acres of landfill area.

KEY PERFORMANCE INDICATORS (AS OF 2015)						
Land use:	20 ha					
Capital investment:	USD 1,114,620					
Labor:	300 (210 unskilled, 90 skilled)					
O&M cost:	USD 5,249/day					
Output:	150 tons of compost / day					
Potential social and/or enviornmental impact:	Creation of 300 jobs, reduction of GHG emissions, waste management cost savings, improved environmental health.					
Financial viability indicators:	Payback period:	3–3.5 years	Post-tax IRR:	N.A.	Gross margin:	N.A.

Context and background

Ludhiana is a centrally located city of Punjab situated between Delhi and Amritsar. It is the industrial hub of Punjab State and the district is agriculturally advanced as the granary of India. It is the most densely populated city of Punjab with a total population of about two million. About 20% of its population is comprised of migrant laborers from Bihar, Uttar Pradesh, Rajasthan and other states, and even from Nepal. As the industrial hub of Punjab State, Ludhiana has experienced a rapid and unplanned expansion of the city, creating an increase in waste generation disproportionate with its management. Amid increasing public criticism of limited and ineffective collection systems and poor disposal practices especially in slum areas, Ludhiana Municipal Corporation entered into a 25-year PPP contract with A2Z to collect and process waste generated from five zones in Ludhiana. A2Z has taken advantage of the deficiencies in the municipality's waste management approach, increasing demand for energy and chemical fertilizer prices, and established a sound and financially sustainable waste management and reuse business. The recovery of resources from the collected waste represents opportunities for A2Z to solidify its business approach. The city's acute power shortage has created a great demand for RDF generated power, suggesting a sustained revenue stream for A2Z. Additionally, considering that Ludhiana is agriculturally advanced, the need for affordable and environmentally sustainable agricultural input options is imperative. The availability of MSW-based compost in the market offers agricultural producers an environmentally safe and cheaper fertilizer alternative. A2Z-PL believes that its activities will help address the health and environmental problems associated with poor waste management and the nexus of energy and fertilizer deficiency in India.

Market environment

Ludhiana, as most cities in India, is facing an alarming energy shortage due to increasing urbanization and industrialization. With dwindling natural energy resources in India, the demand for renewable energy sources such as bio-energy is growing, which has resulted in a demand surge for related inputs such as RDF. Although A2Z Group has established profitable businesses in many cities in India (for example, Varanasi, Meerut, Jaunpur, Moradabad, Badaun, Fatehpur, Basti, Loni, Mirzapur and Ranchi), it is relatively new in the organic fertilizer market in Ludhiana and currently penetrates a very small share of the market. The market for compost is in its nascent stage while that for substitute goods

such as chemical fertilizer has a well-established market and currently controls the largest share of the fertilizer market. Key drivers incentivizing farmers to use chemical fertilizer over more environmentally sustainable alternatives such as organic fertilizers–compost have been related to subsidy provision, and the high nutrient content and low application rate of the product. Although compost provides the dual advantage of price competitiveness and improved crop yields, these benefits typically occur on a long-term basis. For subsistence and smallholder farmers, additional incentives need to be put in place to encourage the use of compost. The Indian government has proposed phasing out the subsidy program to incentivize farmers to use chemical fertilizers more efficiently, lower related costs to the government and increase the adoption of environmentally sustainable alternatives – organic fertilizer.

Macro-economic environment

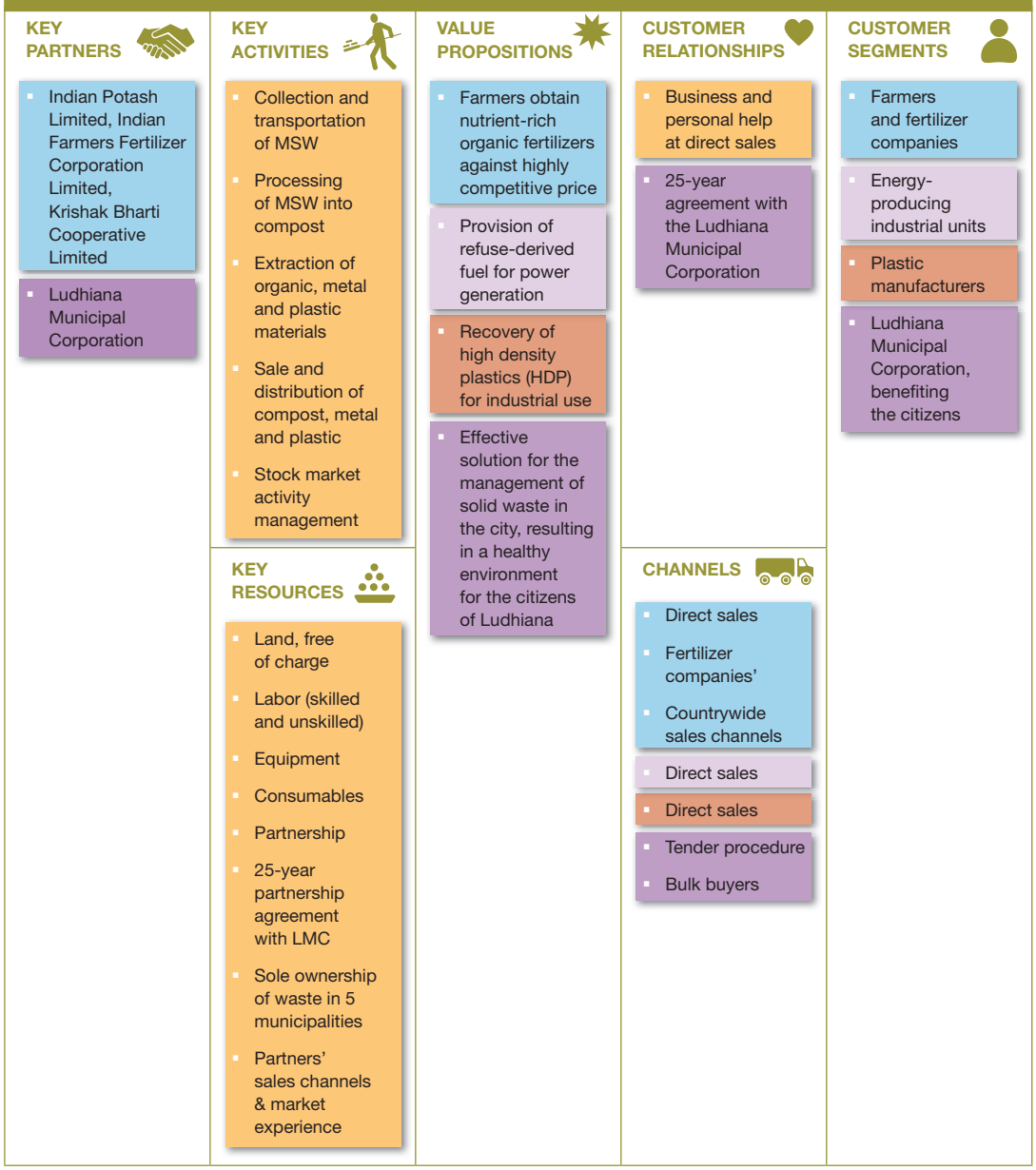
Chemical and synthetic fertilizers, particularly Nitrogen, Phosphorus and Potassium (NPK), are highly subsidized in India. The amount of subsidies on chemical fertilizer has grown in the last couple of decades from Rs.60 crore[2] during 1976–1977 to Rs. 349,980 crores in 2009–2010. Significant subsidy allocation has not only resulted in inefficient use by farmers and high costs to the government, but also significant soil degradation (NCOF, 2017). With a growing need to increase the availability and quality of bio-fertilizers and composts in the country for agricultural productivity improvement while still maintaining soil health and environmental safety, India set up a scheme to augment the infrastructure for the production of quality organic and biological inputs. As a result, the National Project on Organic Farming was birthed in 2004. This programme introduced the capital investment subsidy scheme for commercial production units for organic and biological agricultural inputs. Implemented by the Department of Agriculture and Cooperation through the National Centre of Organic Farming (NCOF), the scheme provides credit linked and back-ended capital investment subsidy equivalent to 33% of total financial outlay subject to the maximum of Rs. 60 lakh per unit, and 25% of total financial outlay subject to a maximum of Rs. 40 lakh per unit, whichever is less for bio-fertilizer/bio-pesticides production units (Ministry of Agriculture, 2011; NCOF, 2017). Policies to reduce the budget allocation for chemical fertilizers and provide capital investments for new and existing compost businesses such as these are important instruments that catalyze the business development in the RRR sector and the scaling-up of initiatives similar to that of A2Z.

Business model

Figure 141 represents A2Z-PL Ludhiana's business model canvas. A2Z Ludhiana's business model is centred around the provision of several value propositions with its success grounded in five principles: 1) using an integrated and inclusive approach via synergies in business operational activities and a public-private partnership (PPP); 2) self-sustainability via a multi-revenue stream approach; 3) zero tolerance for compromise of product quality; 4) maximum resource derivation; and 5) strict compliance to regulations. A2Z-PL Ludhiana has a 25-year partnership agreement with Ludhiana Municipal Corporation (LMC) to collect and process all solid waste generated within the municipality. This partnership gives A2Z sole ownership, i.e. continuous and unrestricted access to waste in five municipalities and provides land free of charge for all operations. With business operations cutting across the entire MSW value chain and increasing land prices, this PPP agreement allows: 1) A2Z to diversify its portfolio, mitigating risk associated with fluctuations in compost demand; and 2) alleviates it of high initial investment costs (optimizing its allocation of resources and activities), whilst the municipality gains from effective waste collection and processing systems. Strategic partnerships with chemical fertilizer companies such as Indian Potash Limited, Indian Farmers Fertilizer Corporation Limited and Krishak Bharti Cooperative Limited allows A2Z to use their established countrywide marketing and distribution system, providing A2Z with an assured and large market base for their compost product. This has proven to be a valuable business approach given that A2Z is a fairly new entrant in the fertilizer market. A2Z-Ludhiana is however gradually increasing its market share via the

branding of its compost by ensuring to maintain a product quality surpassing the recommendations of the Fertilizer Control Order (FCO) board and selling at competitive market prices. Based on fertilizer application recommendations, A2Z's compost sold at USD 0.05/kilogram is comparatively cheaper than chemical fertilizer at a cost of USD 1. Another element to A2Z's pricing strategy is that it segments its compost market by selling to bulk buyers at USD 0.025/kg which is half of the price paid by retailers. Recovered non-degradable materials (high-density plastics and metals) are sold directly to plastic companies and industrial units. Additional revenue is earned from waste collection fees paid directly

FIGURE 141. A2Z-PL (LUDHIANA) BUSINESS MODEL CANVAS



COST STRUCTURE

- Capital including trucks and trolley, dumpers, compressors, JCB machinery with tippers
- Operation and maintenance

REVENUE STREAMS

- Sales from compost
- Sales from metals – RDF
- Sales from high density plastics
- Waste collection fees/charges from LMC
- Floating of shares in the stock market

SOCIAL & ENVIRONMENTAL COSTS

- Pressure on existing infrastructure and congestion (i.e. if collection timings are not adjusted according to normal traffic schedule)
- Increased human exposure to chemical pollutant (i.e. compost having LDP and other non-degradable waste may be harmful for the crops)

SOCIAL & ENVIRONMENTAL BENEFITS

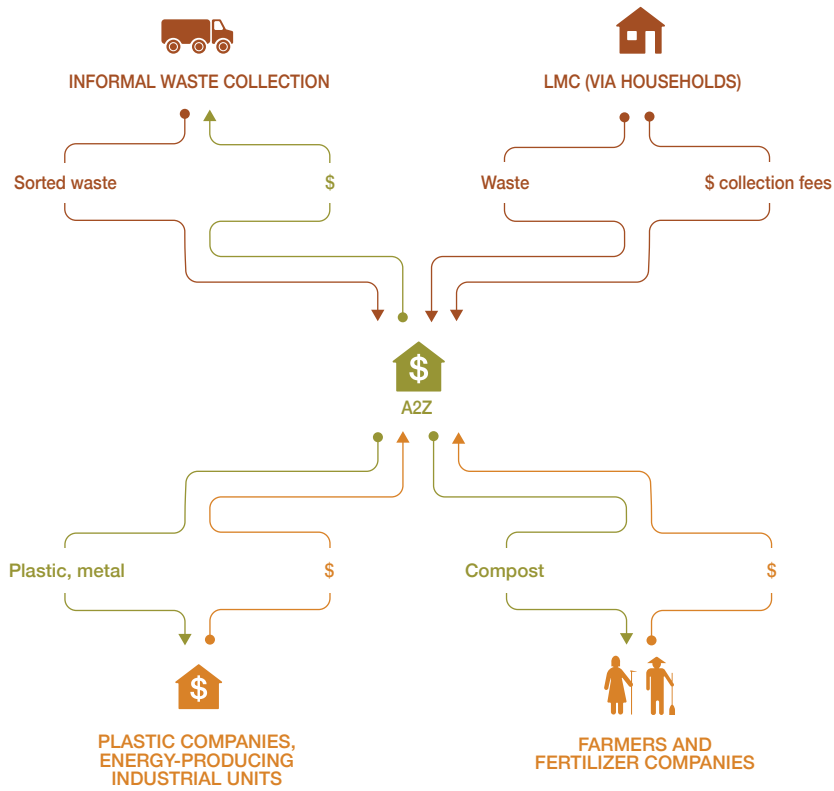
- Reduced existing pollution to water bodies
- Reduction of existing waste management costs
- Reduced human exposure to untreated waste
- Significant job creation
- Reduced consumption of natural energy sources Environmental benefit through reduced CO_2 emissions from electricity generation from renewable sources
- Reduced incidence of infectious diseases, as noted by citizens

by LMC (recovered from household) at a rate of USD 7 per ton of waste collected. Also, essential to the model is the company's shares it floats in the stock market to generate additional revenue.

Value chain and position

A2Z's business operations cut across the entire MSW value chain – from collection and transportation of waste to processing and disposal. The value chain involves three key actors namely: waste suppliers – LMC and informal waste collectors; compost clients – fertilizer companies and farmers; inorganic material clients – plastic manufacturers and energy-producing industry units (Figure 142). A2Z is the focal point in the value chain. The raw material used by A2Z for compost production is municipal solid waste sourced directly from households and markets via informal waste collectors under permission from LMC. There is no competition from other entities in terms of input supply given the contractual agreement between A2Z and LMC, which ensures continuous and unlimited access to the waste from five zones in Ludhiana. A2Z contracts out some its waste collection activities to informal waste collectors. This has not only improved the livelihoods of landfill ragpickers by ushering them into mainstream jobs but has allowed A2Z to efficiently cover slum areas where poor road infrastructure make them less accessible. Compost produced by A2Z is sold mainly to chemical fertilizer companies who process the compost further or sell as is through their established distribution systems. With A2Z been fairly new in the organic fertilizer market and depending on others to access markets, they are also facing high price risk as the chemical fertilizer companies have a high buyer power. There is an increasing number of competitors – organic fertilizer businesses entering the market. Product branding strategies and field demonstrations to validate the product quality is been adopted by A2Z to gradually increase its market access and share. On the other hand, the demand for inorganic materials (i.e. RDF, high density plastics) is high and growing, although A2Z is not yet in a position where it can dictate the selling price.

FIGURE 142. A2Z-PL'S (LUDHIANA) VALUE CHAIN



Institutional environment

The institutionalization of the Municipal Solid Waste (Management & Handling) Rules 2000 has resulted in the provision of bins for households by LMC which has facilitated the collection and reuse of MSW in Ludhiana and the resulting business activities of A2Z. In terms of production, there is currently a statutory guideline – the Fertilizer Control Order (FCO) instituted by the Ministry of Agriculture and Rural Development for the production and distribution of all fertilizers including organic fertilizer. Product quality recommendations are provided for different organic fertilizer types for which producers have to adhere to. This is particularly beneficial to farmers as they get what they are paying for, but also for compost businesses as they are able to build their product brand. Although yet to be fully implemented, the phasing out of the subsidy program for chemical fertilizers by the Indian government represents an opportunity for compost producers to gain an easier entry into the fertilizer market.

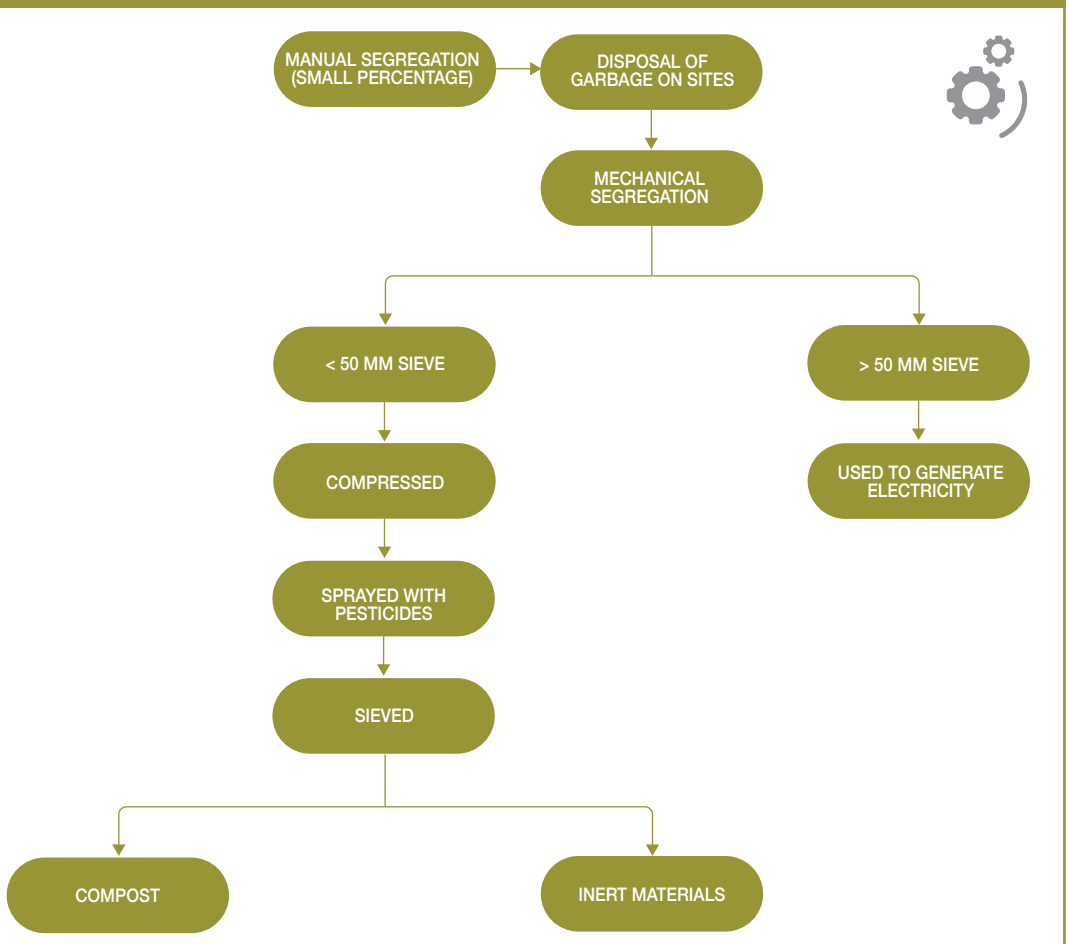
Technology and processes

Open-windrow composting system is the technology adopted by A2Z for processing MSW into compost (Figure 143). The technology has a high rate of recovery for the bulking material and thus suitable to composting large volumes of waste. Although this technology is not space efficient, it has low capital investment requirements as it is manufactured locally and has the capacity to handle large volumes of waste at a time. The first process includes collection and sorting of the waste. Sorting out waste into biodegradable and non-biodegradable portions is mainly a mechanized process although

some level of segregation is manually done by the informal waste collectors serving mainly the slum areas. Waste of particle size greater than 50mm are separated, shredded, packaged and sold partly to electricity-generating units and cement and tile manufacturers. A precentage of the RDF material is sold and the remaining is burnt to generate electricity at one of A2Z's plants at Nakodar, where 15MW electricity is generated.

The organic component of separated waste (partical size <50mm) undergoes the composting process. The waste is piled into windrows. The additional aeration from the bottom of the pile allows microorganisms to decompose the organic waste efficiently through better oxygen supply and improved temperature control. Within 24 hours the micro-organisms within the waste start to multiply and generate heat. Pile temperature increases to 55–65°C, which is optimal for aerobic composting. To enable the micro-organisms to obtain sufficient oxygen, the pile is additionally aerated by turning the waste from time to time (approximately once a week depending on the temperature reached). High temperature leads to water losses through evaporation, so additional water must usually be added with each turning. After 40 days of composting the temperature has decreased, indicating a slowing

FIGURE 143. PROCESS DIAGRAM OF A2Z-LUDHIANA



down of the process. As less oxygen is demanded, the raw compost enters the maturation phase. For another 15 days, mesophilic micro-organisms further stabilize the compost leading to the final mature compost product. The final stage involves screening the piles for undecomposed materials and unwanted products. The compost product is then bagged into different weights for sale.

Funding and financial outlook

The investment cost at the start of the business is estimated at USD 1,114,620. Land for plant operations is provided for free and on a long-term lease basis from the Ludhiana Municipal Corporation. Operation and maintenance costs comprising of wages, salaries, fuel and other consumables are estimated at USD 5,248/day. A2Z receives financial support in the form of a 10% subsidy to cover operational and investment costs offered by the Jawaharlal Nehru National Urban Renewal Mission (a city-modernization scheme launched by the Government of India under Ministry of Urban Development). A2Z generates revenue from the sales of compost, non-degradable materials (plastic and metals) and waste collection fees. Collection fees of USD 7.4/ton of collected waste paid by LMC is sufficient to exactly cover the costs of waste collection and transportation and thus surplus revenue (i.e. profit) comes from compost and inorganic materials sales. On a yearly basis A2Z-Ludhiana makes a net profit ranging between USD 465,290 and 558,348, indicating a 3–3.5-year payback period.

Socio-economic, health and environmental impact

The simple idea of converting the high organic content of the waste into compost has brought about a valuable substitute for chemical fertilizers. Overuse of chemical fertilizers has been a serious problem in India, which has led to severe soil degradation and a costly venture for the government. Farmers now have real alternatives to chemical fertilizers and have the potential to increase their per hectare yield and soil health, which will improve agricultural productivity in the long term. A2Z's activities have so far had an immense impact in addressing the health and environmental problems associated with the unhygienic collection, open transportation and dumping of waste. Ludhiana citizens have noted that the waste management activities of A2Z has significantly reduced the risk of spreading of diseases (such as malaria, diarrhoea and cholera) through the proper collection and disposal of municipal solid waste. Additionally, improved collection systems have reduced water pollution and there is limited to no indiscriminate disposal of waste into nearby flowing *Budha Nala* (water bodies) and sewer pipes. A2Z's business activities has created 300 jobs (both skilled and unskilled) and counting along the entire MSW value chain – from informal waste collectors to plant workers, reducing the level of unemployment in Ludhiana.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Increasing fertilizer prices and industrial demand for power supply, which suggest a foreseeable increase in the demand for the recovered resources – RDF, compost and high-density plastic.
- Strong industrial development and agriculturally advanced status in the area go hand-in-hand, requiring a solution that works both ways.
- Strong commitment of state government in providing an enabling environment for the implementation of the public-private-partnership.
- Positive reporting of A2Z's activities and potential benefits by media.
- Widespread public acceptance of A2Z activities has facilitated their waste collection activities.
- Policy initiatives to phase-out chemical fertilizer subsidies and capital investment subsidies to new and existing compost businesses.

A2Z's model has a high replication potential in cities of developing countries with the support from external support agencies as well as local entrepreneurs. Adopting a labor-intensive, cheap and low

technological approach, the business does not require a large capital investment (except for land purchase) or state of the machinery, which removes one of the major constraints for business start-ups especially in the developing world context. But if scaling up can be achieved, then an advanced technology will have to be adopted. Public support is needed to dismantle the existing system of paving way for systematic disposal for which public awareness is needed. Additionally, field demonstrations to validate compost product quality are necessary to increase a business's entry into the fertilizer market as oftentimes compost sales constitute a fair share of the revenue generated and thus key factor for business sustainability.

Summary assessment – SWOT analysis

Figure 144 presents the SWOT analysis for A2Z-Ludhiana. Composting is a promising business in India, although a nascent market in Ludhiana. A2Z has been particularly successful by implementing innovative business partnerships with different actors across the entire value chain. Self-sustainability has been driven by a multi-revenue stream approach and gradually gaining market share via product branding. The use of a simple technology has been key – taking advantage of cheap labor; however with increasing wages, A2Z will have to consider other alternatives with future expansion plans. Increasing

FIGURE 144. SWOT ANALYSIS FOR A2Z-LUDHIANA

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ Already in business and thus has experience, expertise and resources at their command ▪ Technology has limited investment and energy requirements ▪ Requires little technical skills or expertise to operate ▪ Continuous and unrestricted access to waste	**WEAKNESSES** ▪ Opposition from private sweepers and farmers close to dumping site ▪ Technology is labor-intensive (costly amid rising wages) ▪ High initial capital investment cost ▪ High cost of maintenance and repairs ▪ Dependency on door-to-door garbage collection by rag pickers ▪ Up-scaling requires adapted technology and more skilled labor
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Government scheme set up for promotion of production of biological/organic fertilization products (set up a scheme to augment the infrastructure for production of quality organic and biological inputs) ▪ Mechanization of activities to increase production and economies of scale ▪ Up-scaling potential for a CDM project to earn carbon credits ▪ Replicate activities in other cities given market entry opportunities with capital investment subsidies and phasing-out of chemical fertilizer subsidies ▪ Possible phasing-out of subsidy on chemical fertilizers	**THREATS** ▪ Increasing and high cost of labor ▪ Well-established and subsidized chemical fertilizer market

governmental support along with growing demand for normal and enriched compost, spurred by the user awareness building programmes, will represent key opportunities for replication and up-scaling of the business. A2Z is an example of an innovative PPP utilizing a simple business approach to address some of the major waste management and environmental challenges in Ludhiana, India.

Contributors

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Personal communication with: Sh. BPS Chauhan (Vice President), Sh. Parmod RM (Human Resources), Sh. Ravinder (Supervisor).

Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2015/16. As business operations are dynamic data can be subject to change.

Notes

1 USD 1 = about INR (or Rs.) 65.62 in 2015.
2 Crore are 100 lakh, and lakh is a unit for 100,000. Rs. 60 lakh were in 2004–2012 about USD 120,000, and about USD 90,000 in May 2017.

CASE

Municipal solid waste composting with carbon credits for profit (IL&FS, Okhla, India)

Solomie Gebrezgabher, Sampath N. Kumar, Pushkar S. Vishwanath and Miriam Otoo

Supporting case for Business Model 12	
Location:	Okhla, India
Waste input type:	Municipal solid waste (MSW)
Value offer:	Provision of an affordable, organic compost and generation of carbon credits
Organization type:	Public-private partnership (PPP)
Status of organization:	Operational since 2008 (registered as Clean Development Mechanism (CDM) project since 2009)
Scale of businesses:	Processes 200 tons of MSW per day (73,000 ton/year)
Major partners:	Municipal Corporation of Delhi (MCD)

Executive summary

The Infrastructure Leasing and Financial Service Okhla composting plant (IL&FS Okhla) started composting operations in 1981 with the aim of avoiding methane (CH_4) emissions generated in the landfill site through the controlled aerobic decomposition of MSW in a windrow composting process. However, the plant was shut down in 2000, as the business was not viable due to insufficient revenues from the sale of the compost. In 2007 IL&FS Ltd. signed a Concession Agreement and a public-private partnership (PPP) with the Municipal Corporation of Delhi (MCD) to rehabilitate the Okhla compost plant on a build, operate and own (BOO) model with carbon finance support. This project demonstrates the significant role of CDM in ensuring sustainable operation of waste reuse businesses while contributing sustainable climate protection. As reported, the plant converts approximately 73,000 tons of MSW into compost every year. The plant has two brands for its compost, the Harit Lehar and the EcoSmart Home Garden, which are both FCO (Fertilizer Control Order) compliant composts sold to farmers and to urban residents. Around 1,600 tons of CH_4 (34,000 ton CO_2eq) emissions are avoided on average per year and it is estimated that 234,231 tons CO_2eq is likely to be achieved within the seven-year renewable crediting period[1]. Moreover, the compost is used as a replacement to chemical fertilizer and thus avoids greenhouse gas (GHG) emissions from the production of chemical fertilizer. Another environmental and economic benefit is that the compost is rich in organic carbon, which increases the soil fertility and farm productivity.

KEY PERFORMANCE INDICATORS (AS OF 2014)						
Land use:	3.27 ha					
Water use:	50,000 L/day					
Capital investment:	USD 1,454,250					
Labor:	10 skilled, 15 unskilled, 14 other adminstrative full time employees					
O&M:	USD 44.5/ton					
Output:	14,600 tons/year					
Potential social and/ or enviornmental impact:	Reduce pollution of water bodies, reduce waste management costs, reduce human exposure to untreated waste, enhance soil fertility and farm productivity, reduce GHG emissions, generate employment					
Financial viability indicators:	Payback period:	6–7 years	Post-tax IRR:	14.48%	Gross margin:	40%

Context and background

IL&FS Environmental Infrastructure & Services Ltd. (IL&FS Environment) is a 100% subsidiary of India's leading non-banking financial institution Infrastructure Leasing & Financial Services Ltd. (IL&FS). Its remit is to enhance the urban environmental infrastructure of Indian cities especially in terms of MSW management including new projects as well as the upgrading, operation and maintenance of non-functional compost plants all over India. The company has extensive experience in providing MSW consulting and advisory services to municipalities, and designing and implementing similar projects within the public-private partnership (PPP) framework in various parts of the country. It operates nearly 16 urban MSW processing facilities across the country, including the Okhla composting facility. The Okhla compost plant was constructed in 1981 and closed in 2000, as the operation was not cost effective due to insufficient revenues from the sale of compost. In May 2007, IL&FS signed a Concession Agreement with the Municipal Corporation of Delhi (MCD) to rehabilitate the Okhla compost plant with carbon finance support. IL&FS is responsible for financing, rebuilding, operating and maintaining the compost plant. The concession also provides exclusive rights and authority to retain, control, own, possess, collect and appropriate all possible revenue that can be generated from or in relation to the Project. The term of the concession is for 25 years from the date of agreement.

Market environment

The rapidly growing urbanization in Indian cities and the resulting increased need for good waste management practices has made MSW a top priority of most urban local bodies. Like the majority of landfills in India, the Okhla landfill was poorly managed and no precautions were taken to avoid the emission of methane. These have created a serious environmental and public health problem. Appropriate waste management is gaining priority with the government. This is evidenced by the fact that the MCD has signed a Concession Agreement with IL&FS to rehabilitate the Okhla compost plant. The Government of India is also supporting balanced nutrient management for agricultural soil in order to ensure that the productivity of agricultural land does not keep declining due to overuse of chemical fertilizers. The compost produced by IL&FS Ltd. is rich in organic carbon and increases soil fertility. The plant has two brands for its compost, the Harit Lehar and the EcoSmart Home Garden, which are both FCO (Fertilizer Control Order) compliant composts sold to farmers and to urban residents. Since the price of the compost is subsidized using revenue from carbon credit, marketing of compost is easier thus ensuring the sustainability of the project. The demand for the compost exceeds production but is highly seasonal. Demand is high from May to June and November to December. IL&FS sells its products through marketing alliances with fertilizer companies but is planning to be involved in direct sales of organic compost. There is competition from substitute products such as press mud, which is cheaper than the compost produced by the company.

IL&FS Okhla compost plant is also planning to produce and sell Refuse Derived Fuel (RDF), which is fuel produced from the combustible components of MSW such as plastics and other biodegradable waste. RDF is an alternative fuel to coal and IL&FS plans to sell RDF to cement industries.

Macro-economic environment

MSW management has become essential in India as there has been a significant increase in MSW generation in the last few decades due to rapid urbanization and high population growth rate. Around 90% of waste is landfilled, requiring around 1,200 hectare of land every year. With the growing population and urbanization, municipal bodies are facing financial pressures and challenges in coping with demands. The municipalities are therefore looking at alternative ways of handling waste by identifying activities that generate resources from waste. The government is encouraging reuse businesses. In addition to this, India signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 and ratified the Kyoto Protocol on 26 August, 2002. The government has a very proactive approach to attract investors to develop CDM projects. India has been ranked first in the world in terms of approved CDM projects and it is considered as one of the countries with high potential for CDM projects. This is partly attributed to the proactive policies of the Indian government towards CDM.

Business model

IL&FS reconstructed the Okhla composting plant and signed a concession agreement with MCD to manage the plant. They obtain revenue from the sale of compost and through the CDM mechanism, by selling carbon credits to UNFCCC Annex I countries[2] (Figure 145). As per the concession agreement with MCD, 25% of the CER earning is shared with MCD for the first five years. The company has not started earning revenues from the by-products (RDF) yet, but it has a contract with cement factories to supply RDF as an alternative fuel to coal in the future. Strong partnership is required with the MCD and good relationships are needed with the customer base, farmers and urban household and organizations maintaining gardens. Sales of compost are either direct or through agreements with fertilizer companies.

Value chain and position

The compost plant receives the MSW from the urban local body, composts the waste, segregates the recyclables and sells the organic compost and recyclables to recover the costs. The MCD is a key partner as it not only supplies the raw materials but also it provided land to set up the facility (Figure 146). The compost is used in the agriculture fields. The company sells its Harit Lehar compost to farmers via fertilizer distributers and its EcoSmart Home Garden compost directly to urban residents and institutions with gardens. The company generates revenue from emission reduction credits and shares 25% of the CER revenue with MCD for the first five years.

Institutional environment

Since IL&FS Okhla composting plant is registered as a CDM project, both the UNFCCC/Kyoto protocol requirements and host country requirements apply. The Municipal Solid Waste Management and Handling Rules, 2000 directed the municipalities to supply only segregated waste to composting facilities but due to financial constraints, municipalities in India have still not implemented the rules. The organic compost is produced as per the Fertilizer Control Order (FCO) rules. MSW Rules 2000 for the overall management of the facility and the FCO rules for the compost quality are adhered to in the operation of the compost facility. The State Pollution Control Board does regular reviews of the facility and provides recommendations, which are to be followed.

FIGURE 145. IL&FS OKHLA COMPOST PLANT BUSINESS MODEL CANVAS

KEY PARTNERS

- Municipal corporation of Delhi (MCD)

KEY ACTIVITIES

- Receive MSW
- Production of compost and other recyclables (RDF)
- Marketing and sale of compost
- Managing CDM process & obtaining emission reduction credit

KEY RESOURCES

- Equipment (composting platform, segregation machinery, vehicles and other)
- Labor
- Consumables (MSW, energy, bio-culture)
- Intangibles (emission reduction)
- Subsidization resources from carbon trade income

VALUE PROPOSITIONS

- Farmers get high organic carbon content compost ('Harit Lehar' brand) against very low price due to subsidy
- Urban residents and institutions with gardens get high organic content compost (Brand EcoSmart Home Garden) against very low price due to subsidy
- Tradable certified emission reduction (CER) credits to meet carbon emission commitments
- Refuse derived fuel (RDF) at low price

CUSTOMER RELATIONSHIPS

- Farmer contact via fertilizer distributors (contract)
- Personal
- Registered as CDM at UNFCCC
- Personal (contract)

CHANNELS

- Marketing alliances
- Direct
- CDM certificate trading
- Direct

CUSTOMER SEGMENTS

- Farmers
- Urban residents and institutions
- Companies from UNFCCC Annex I countries
- Cement industries

COST STRUCTURE

- Investment cost:
  - Civil works
  - Plant cost
  - Equipment
- Annual operating cost
- Interest on borrowed funds
- MCD share payment
- Compost subsidization

REVENUE STREAMS

- Sales of compost Harit Lehar
- Sales of compost EcoSmart Home Garden
- Expected Sale of CDM benefits
- Sale of RDF (planned)

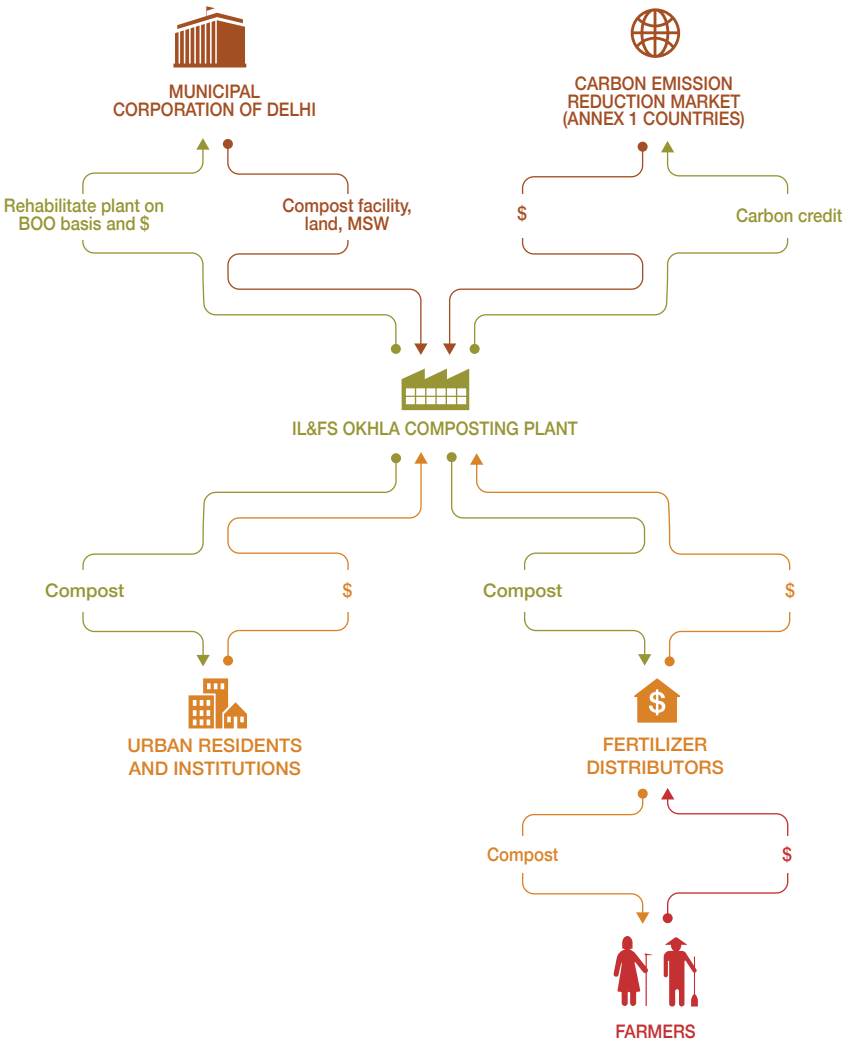
SOCIAL & ENVIRONMENTAL COSTS

- Possible human health risk while handling MSW

SOCIAL & ENVIRONMENTAL BENEFITS

- Reduced pollution of water bodies (about 1,000 litres of leachate is treated in the facility)
- Reduced existing waste management costs
- Reduced human exposure to untreated waste and chemical pollutants
- Enhanced soil fertility and productivity
- Reduced GHG emissions
- Employment generation

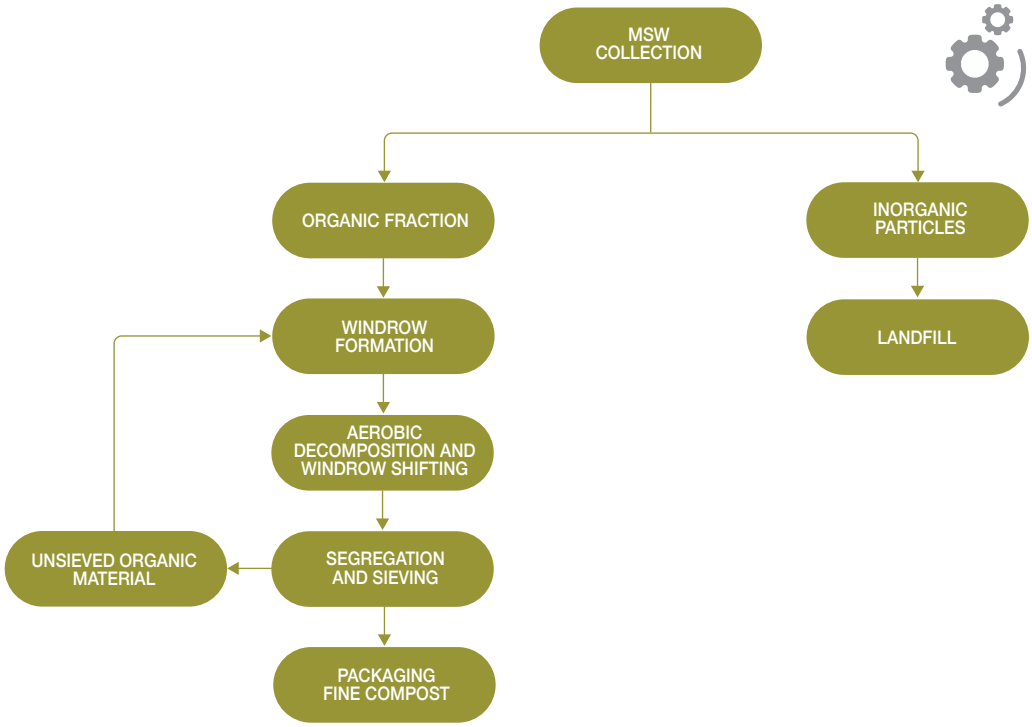
FIGURE 146. IL&FS OKHLA COMPOSTING VALUE CHAIN



Technology and processes

The technology used in the composting process is open windrow aerobic composting. Figure 147 depicts the composting process. The first step in the composting process is that the waste carried by the trucks is weighed and undergoes pre-sorting in which most of the large inorganic particles are separated out. The leachate is pumped to a separate treatment tank and the treated water is reused for the composting process. Inert materials and plastics are removed using sieving machines. The rejects are sent to landfill. The screened organic rich waste undergoes the process of composting. The duration of the composting process is about one month. During this period, the waste is sorted into windrows and undergoes turning and heaping. The compost pad is a concrete platform on which waste is allowed to undergo decomposition. The windrows are turned and shifted once a week using loaders for aeration and temperature control to enable aerobic decomposition of waste. A bio-culture is

FIGURE 147. IL&FS COMPOSTING PROCESS



sprinkled on the waste heaps to aid growth of microorganisms and speed up the composting process. The temperature and oxygen of the waste heaps are measured and recorded every week. After four to five weeks, the composting heap is shifted to the "monsoon shed" for further stabilization. Next, it is sieved and the remaining inert and inorganic materials are separated out. To achieve maximum screening efficiency, one vibrating screen of 35mm and one trammel of 14mm are used. Cascading action inside the trammel ensures better screening of the waste. Screened material coming out after composting is uniform in texture and contains pure organic compost while the unsieved organic material is recycled back to the windrows for further degradation. The quantity of compost produced is about 15–26% of the quantity of MSW by weight. The NPK content of the compost is respectively 0.4%, 0.4% and 0.8%, organic matter of 50–60% and carbon content of 12%. The equipment used in the composting process is locally produced and spare parts can be easily purchased. However, the equipment needs frequent repairs. In terms of efficiency of the technology, there is a rapid composting technology which is more efficient than the one used by IL&FS but the cost is much higher.

Funding and financial outlook

The total investment cost of the project is USD 1,454,250. The civil works and plant costs account for more than 50% of the total project cost and equipment and other costs account for 42% of the project cost. Land was provided by the MCD. Financing was split between the owner's equity (24% of the total project cost) and debt (74%) at an interest rate of 14%. Table 37 gives the projected annual profits assuming that the first-year capacity utilization is 50% and the second year onwards, it is 100%. The plant has a capacity of producing 14,600 tons of compost and the selling price is 2,000 Rs./ton (USD 40/ton).

TABLE 37. FINANCIAL SUMMARY AND PROJECTED PROFITABILITY OF IL&FS COMPOST PLANT WITH CDM BENEFIT (USD)

ITEM	2008	2009	2010	2011	2012	2013	2014	2015	...
Investment cost:									
Land	0								
Civil works	425,250								
Plant cost	417,500								
Equipment	330,250								
Other cost	282,250								
Total investment	***1,454,250***								
Revenue:									
Compost sales	365,000	613,200	643,860	676,053	709,856	745,348	782,616	821,747	...
Sales of CER	49,850	121,937	203,111	278,173	347,606	411,850	471,312	0	...
Total revenue	**414,850**	**735,137**	**846,971**	**954,226**	**1,057,461**	**1,157,198**	**1,253,928**	**825,747**	**...**
Total expense	451,134	613,714	630,939	649,105	668,266	688,475	709,792	732,280	...
PBDIT	**(36,284)**	**121,422**	**216,032**	**305,121**	**389,196**	**468,723**	**544,135**	**89,467**	**...**
Interest	154,000	118,580	106,260	47,740	27,207	23,100	18,993	14,887	...
Depreciation	67,235	53,788	53,788	53,788	53,788	53,788	53,788	53,788	...
PBT	**(257,519)**	**(50,946)**	**55,983**	**203,593**	**308,201**	**391,835**	**471,354**	**20,792**	**...**
Income tax	0	0	4,714	17,143	25,951	70,089	158,192	10,119	...
Profit after tax	**(257,519)**	**(50,946)**	**51,270**	**186,450**	**282,250**	**321,746**	**313,162**	**10,673**	**...**

Projected IRR (%)	**14.48**
NPV (USD)	**482,398**
Payback period	**6–7**

PBDIT = Profit before depreciation, interest and tax; PBT = Profit before tax

Assuming a discount rate of 10% and useful life of 25 years, with benefits from CDM, the project is viable and results in a positive net present value (NPV) and an internal rate of return (IRR) of 14.48% and payback period of six to seven years. Under the scenario where there is no revenue from CDM, the plant does not break even and results in a negative NPV and IRR of 7%.

Socio-economic, health and environmental impact

The business was set up to reduce the burden on the environment caused by untreated MSW waste. The compost plant treats biodegradable waste and on average it diverts approximately 73,000 tons of MSW per year (200 tons per day) and thus reduces the amount of waste disposed in landfill sites. The project avoids the emissions of methane that would be produced by landfill and thus contributes to

GHG emissions reduction. Around 1,600 tons of methane (34,000 ton CO_2eq) emissions are avoided on average per year and it is estimated that 234,231 tons CO_2eq is likely to be achieved within the seven years' crediting period. Moreover, the compost is used as a replacement to chemical fertilizer and thus avoids GHG emissions from the production of chemical fertilizer. About 1,000 litres of leachate is also treated in the facility which would otherwise get into the underground water. The organic compost is rich in organic carbon content and increases the soil fertility and farm productivity. The company had conducted field trials in the district of Agra, Uttar Pradesh state to check the yield gain using the organic compost, which was shown to be 25%–30% higher than the yield obtained using chemical fertilizers. In addition to its environmental benefit and contribution to better management of MSW, the project generates employment opportunities. The plant is semi-mechanized and created jobs for local people directly in the composting facility and indirectly through waste collection and transportation of compost to the end user. It also results in reduced human exposure to untreated waste and chemical pollutants.

Scalability and replicability considerations

The key drivers for the success of this business are:

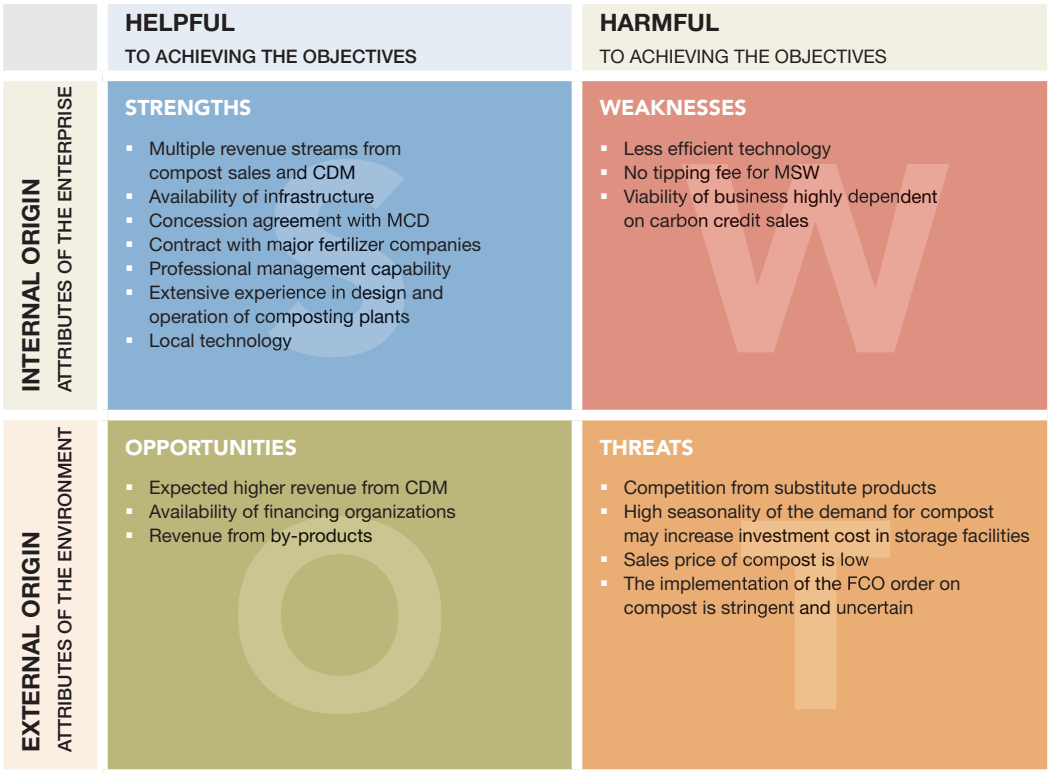
- Strategic PPP model with the municipal corporation of Delhi (MCD).
- Government support and proactive policies towards CDM.
- Government encouragement of reuse businesses.
- Innovative financing scheme and sharing of benefits between municipality and IL&FS.
- Rapid urbanization combined with high population growth.
- Government support/priority to appropriate MSW management and sustainable soil (fertility) management.

The design and operation of this project, in conjunction with the avoidance of GHG emissions and production of compost as a soil amendment, will serve as an example to many other urban areas in countries that are facing similar waste management challenges. The IL&FS composting uses a holistic approach to processing waste where almost all waste types both degradable and non-degradable are used. The technology is semi-mechanized, simple and relatively inexpensive. In regards to scaling up or scaling out, IL&FS has developed and transferred similar waste management projects to other Indian regions. For example, RWE (German Power Supplier) and IL&FS are working in cooperation on two further composting projects close to Delhi and Varanasi, India. Both were registered as CDM at the UNFCCC in 2009. This project has a good potential to be replicated in other countries. Replicating this business in a locality close to landfill sites will reduce transportation cost and increase performance of the business. Receiving tipping fees for the MSW which does not exist in the case of IL&FS compost plant would also reduce production cost. However, a major limitation for setting up a composting plant of similar scale of operation and which would qualify to be considered as a CDM project, is the high capital requirement, especially in localities yet to be developed in terms of infrastructure. In order for this business to be replicated in other countries, strong partnerships with local authorities (municipalities) along with innovative financing mechanisms and good expertise in waste management practices are important.

Summary assessment – SWOT analysis

Figure 148 presents the SWOT analysis for IL&FS Okhla compost plant. Key strengths of the business are its strong partnership with the Municipal Corporation of Delhi (MCD) and its multiple revenue streams from sales of compost and CER credits. However, the carbon credit market is highly volatile, which puts the sustainability of the business under risk. This can be mitigated through additional revenues from by-products such as RDF, which can replace coal used in cement industries.

FIGURE 148. SWOT ANALYSIS FOR IL&FS OKHLA COMPOSTING PLANT



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Case descriptions are based on primary and secondary data provided by case operators, insiders, or other stakeholders, and reflect our best knowledge at the time of the assessments 2014/15. As business operations are dynamic data can be subject to change.

Notes

1 The crediting period for a CDM project is the period for which reductions from the baseline are verified and certified by a designated operational entity for the purpose of issuance of certified emission reduction (CERs). The crediting period for IL&FS is 7 years.

2 Industrialized or transitional economies as listed in Annex I of the United Nations Framework Convention on Climate Change (UNFCCC). http://unfccc.int/parties_and_observers/parties/annex_i/items/2774.php (accessed November 8, 2017).

CASE

Partnership-driven municipal solid waste composting at scale (KCDC, India)

Miriam Otoo, Sampath N. Kumar, Pushkar S. Vishwanath and Lesley Hope

Supporting case for Business Model 12	
Location:	Bangalore, Karnataka, India
Waste input type:	Municipal solid waste
Value offer:	Provision of waste management services and high quality compost for agricultural purposes; provision of consultancy services for waste management
Organization type:	Public entity (government-owned corporation)
Status of organization:	Operational since 1975
Scale of businesses:	Processes 300 tons of municipal solid waste per day
Major partners:	Bruhat Bengaluru Mahanagara Palike (BBMP), Karnataka Agro Industries Corporation (KAIC), Karnataka State Co-operative Marketing Federation (KSCMF)

Executive summary

Karnataka Compost Development Corporation Limited (KCDC) is one of the oldest public entities involved in the production of compost from municipal solid waste (MSW) for agricultural purposes in India. The business of compost production provides significant value to KCDC by offering viable options for cost recovery and ensuring sustainable sanitation services provision. KCDC has been particularly successful by using an innovative business partnership model. Its strategic partnerships with other local government entities and private enterprises have allowed it to optimize the allocation of resources and activities reduce risk associated with high capital investments and establish an assured market for their product. Another important success driver has been KCDC's ability to mold its business to local context elements. The use of a simple and labor-intensive technology not only gives KCDC a competitive advantage for production, but also generates employment particularly for low-income persons who would otherwise be unemployed. An additional socio-economic benefit from KCDC's businesses the reduction in chemical fertilizer imports from increased usage of organic compost. This in turn has significant ecological benefits, reducing residual chemical pollutants in soils and water bodies.

KEY PERFORMANCE INDICATORS (AS OF 2014)						
Land use:	6 ha					
Capital investments[1]:	USD 910,000					
Labor:	40 (13 skilled, 20 unskilled, 7 administrative)					
O&M cost:	USD 12,400/ day					
Output:	10,000–16,000 tons of compost per year					
Potential social and/or environmental impact:	40 direct jobs created with worker earnings higher than minimum wage; increased crop yield and reduced costs of fertilizer use, reduced waste management costs, reduced human exposure to untreated waste					
Financial viability indicators:[2]	Payback period:	7 years	Post-tax IRR:	N.A.	Gross margin:	N.A.

Context and background

Karnataka Compost Development Corporation Limited (KCDC) is a 39-year-old company based in Bangalore engaged in the business of hygienic disposal of solid wastes generated in Bangalore city through composting. The city of Bangalore, the capital of Karnataka, has a population of about 8,000,000 and generates about 3,500 to 5,000 tons of solid waste per day. With an ever-increasing urban population and limited waste management budgets, the local government invested in several integrated resource recovery facilities with the dual purpose of cost recovery and rehabilitating agricultural lands. Bangalore has a number of waste processing facilities at various locations, which are of larger processing capacity ranging from 200–1400 tons per day but KCDC remains one of the few still functioning. KCDC was incorporated in the year 1975 with an equity capital of USD 84,690[3] (in 2014 currency value) as equity infusion. The company started by setting up a composting plant using international technology along with 11 other similar plants across the country. The highly mechanized technology proposed was not sustainable for the Indian context and all the plants of similar technology closed down by 1980. KCDC was the only one who continued operations by doing incremental changes to its technology and by early 1990 transitioned completely to the use of an indigenized technology. Given its success, in 2000, KCDC received a subsidy of USD 34,000 from the Government of India to set-up a bio-fertilizer plant. KCDC is a state government entity with equity participation from Karnataka Agro Industries Corporation (KAIC), Bruhat Bengaluru Mahanagara Palike (BBMP) and Karnataka State Cooperative Marketing Federation (KSCMF). The principal shareholder is KAIC, which falls under the agricultural department of the Government of Karnataka. BBMP is the urban local body of Bangalore city and is responsible for municipal waste management in the city. The role of BBMP is to supply municipal solid waste to KCDC. Originally, the role of KSCMF was envisaged to support KCDC with marketing, however overtime KCDC has established its own marketing strategies for its products. KCDC is possibly the only government owned and longest operating municipal waste processing company in India. The waste processing facility of KCDC is located at Haralakunte, near Singsandra, about 13 km from the centre of Bangalore.

Market environment

Sanitization of waste is seen traditionally as a public sector obligation and consumes a large percentage of municipal budgets. A key challenge is managing the daily generation of millions of cubic meters of solid and liquid waste. The potential combinations of domestic, commercial and/or industrial waste streams are primarily viewed as a threat on which the public sector must spend resources to sanitize. Appropriate sanitation services to safeguard public health are however as expensive as they are crucial for exploding cities, consuming most of the municipal budget. Additionally, increasing chemical fertilizer prices, continuous degradation of agricultural soils from over-application of chemical fertilizer and subsequent reductions in crop yields have caused the government of India to shift to a

soil nutrient based fertilizer plan and promoting organic agriculture. KCDC thus took advantage of the government's push for organic agriculture to convert readily available MSW into organic fertilizer for use in the agricultural sector. The size of the organic fertilizer market although fairly large and growing, is comprised of 90% of animal-manure based fertilizer producers. Of the remaining 10% that is non-animal manure-based; the majority of businesses is small-sized and found in the informal sector. These businesses generate demand for their product based on field demonstration, personal relationships and reputation. There have been many products that have been promoted and have not been found useful on the ground. The market acceptability especially for organic compost is based on proof by demonstration and product branding. The compost produced by KCDC competes with the numerous organic fertilizer products produced by private manufacturers as well as imported chemical fertilizers. KCDC, however, has a competitive advantage, as its product is priced lower than the average market price and is able to do this partly due subsidy receipts from the government.

Macro-economic environment

Significant increase in MSW generation in the last decades due to rapid urbanization and high population growth rate has put the identification of sustainable waste management systems at the forefront of local government issues. Around 90% of generated waste in Bangalore is currently landfilled, requiring around 1,200 hectares of land every year. The ever-increasing cost of waste management has limited public investment in other economic sectors. Additionally, chemical and synthetic fertilizers are highly subsidized in India, and this has not only led to inefficient use by farmers and high costs to the government; significant soil degradation has also been observed as a result. To curb public spending on waste management services and chemical fertilizer subsidies, the Indian government has implemented a number of schemes that support the reuse of waste. With a growing need to increase the availability and quality of bio-fertilizers and composts in the country to improve agricultural productivity while maintaining soil health and environmental safety, India has set up a scheme to augment the infrastructure for production of quality organic and biological inputs.

Accordingly, under the National Project on Organic Farming a capital investment subsidy scheme provides credit linked and back-ended capital investment subsidy equivalent to 33% of total financial outlay subject to the maximum of Rs. 60 lakh[4] per unit and 25% of total financial outlay subject to a maximum of Rs. 40 lakh per unit for commercial production units for organic and biological agricultural inputs has been introduced (see Case A2Z Infrastructure Limited in Chapter 9).

Business model

KCDC is a state government corporation that converts municipal solid waste into organic fertilizer for agricultural purposes. It also provides consultancy services (expertise on technology) to other waste processing companies. It partners with Karnataka Agro Industries Corporation (KAIC), Bruhat Bengaluru Mahanagara Palike (BBMP) and Karnataka State Co-operative Marketing Federation (KSCMF). All the partners contributed to the initial capital investment and are current shareholders in the company. The partnership with BBMP gives it access to municipal solid waste. Although the originally envisaged role of KSCMF was to support KCDC in marketing, overtime KCDC established its own marketing brand and has been successful in increasing its share of the organic fertilizer market. Essential aspects of KCDC's model are its marketing strategy and technology use. The major compost products are marketed through government institutions, dealers' network, KAIC retail outlets and direct selling to consumers. KCDC uses these intermediaries to sell its products to rural and urban farmers, plantation owners, nurseries, floriculturists, landlords and urban households. KCDC captures the large rural market through the well-organized distribution channels of government institutions with which farmers are familiar. The use of dealer networks has widened their market coverage, allowing them to capture most of the Karnataka state and some parts of the Tamil Nadu and Kerala market. KCDC sells

to the marginal farmers through the state's agricultural department with a 50 per cent subsidy, under a scheme to promote organic farming. In addition, KCDC gives a discount on metric ton basis to private buyers. The promotion and marketing strategies adopted by KCDC have doubled its sales in the past one year. Another key sustainability factor of KCDC is its technology, which is simple, indigenous and has low-energy and investment requirements. KCDC has mastered the technology of aerobic windrow composting and vermicomposting and its expertise has been recognized by many municipalities who are now seeking their technical and managerial advice; for which KCDC now generates revenue from their consultancy services. See Figure 149 for diagrammatic representation of the business model for KCDC.

Value chain and position

Figure 150 opposite presents KCDC's compost value chain and position. KCDC was built with equity from three government entities: BBMP, KAIC and KSCMF to promote sustainable waste management and agricultural production practices. The City of Bangalore generates about 3,500 tons of solid waste per day. The capacity of existing facilities is insufficient to process all of the city's quantity of waste and is currently overloaded. KCDC has a contract with BBMP for the supply of 600 tons of MSW each day of which only 50% is being processed. Even with the entry of new organic fertilizer businesses in the market, there is adequate availability of waste for KCDC's operation and even for future scaling-up of operations. KCDC produces two types of compost, namely: (a) regular compost marketed as BIO AGRO; and (b) enriched compost marketed as BIO AGRO RICH (which is enriched with micro nutrients). KCDC's customers are mainly directorates of agriculture, horticulture and sericulture, estate plantations, smallholder farmers and households. As partners, KAIC and KSCMF are responsible for establishing a solid marketing and distribution network for the products. KCDC sells their products through dealer networks, KAIC retail outlets and the existing distribution channels of Karnataka state departments of agriculture. The compost is sold to marginal farmers with a 50 per cent subsidy under a scheme to promote organic farming. Pricing is based on cost of production and a profit mark-up. BIO AGRO is sold at Rs. 1,000/ton in loose form and Rs. 1,550/ton if bagged. BIOAGRO RICH is sold at Rs. 1,500/ton in loose form and Rs. 1,850/ton if bagged. All pricing includes transportation up to 100 kilometres and free loading charges. An additional government subsidy of Rs. 30/ton is provided if the user segment is farmers.

Chemical and other organic fertilizers found on the market are good substitutes for KCDC's BIO AGRO and BIO AGRO RICH. Terra Firma Biotechnologies Limited is a major competitor in the market and produces a variety of equally high quality compost products tailored to different customer segments. Additionally, Terra Firma implements a door-to-door sales strategy (direct sales) for urban households and uses HOPCOMS outlets to reach larger scale agricultural producers which have worked well to increase its market share. Terra Firma's products are however perceived to be an up-market product as they are not cost-effective for marginal farmers. Terra Firma thus has had to focus on the household and large-scale farmer segments. With government subsidies, KCDC's products are the most cost-effective product on the market given its quality (high nutrient levels and compliance with safety standards). KCDC seems to be the market leader compared to the main competitor, Terra Firma, mainly due to its long-standing existence; however, if government support and subsidies are withdrawn, the survival of the product is doubtful.

Institutional environment

There are no legal or regulatory policies that limit the processing of MSW to organic fertilizer products. The key regulation is that waste reuse businesses assure the safety of all actors involved in the business operations and the quality of the product as outlined in the Municipal Solid Waste (Management and Handling) Rules, 2000. In terms of production, there is a statutory guideline – the Fertilizer Control

Order (FCO) instituted by the Ministry of Agriculture and Rural Development for the production and distribution of all fertilizers including organic fertilizer. Product quality recommendations are provided for different organic fertilizer types for which producers have to adhere to. This is particularly beneficial

FIGURE 149. KCDC'S BUSINESS MODEL CANVAS

KEY PARTNERS

- Karnataka Agro Industries Corporation (KAIC)
- Bruhat Bengaluru Mahanagara Palike (BBMP)
- Karnataka state co-operative marketing federation (KSCMF)
- Marketing and transport agents

KEY ACTIVITIES

- Composting
- Marketing and distribution support to other waste composting facilities across Karnataka
- Distribution of organic manure to rural communities
- Provision of consultancy services
- Branding, marketing & sales
- Delivery services

KEY RESOURCES

- Financing (crucial for start-up, new technology development);
- Subsidies (imperative for market development)
- Infrastructure and equipment
- Labor
- Easy access to waste input through its partnership
- Consumables (MSW waste, worms)
- Knowledge, expertise
- Brand image

VALUE PROPOSITIONS

- Agricultural producers have easy access to high quality compost tailored to their specific needs, for a highly competitive price
- Consultancy services on compost production processes to other companies
- Informal sector participants – rag pickers have access to low-priced inorganic recyclables for sale
- Environmental friendly solution for disposing off the sugar mill waste, while earning extra profits

CUSTOMER RELATIONSHIPS

- Direct and indirect relations with dealers and retailers
- Direct service
- Direct sale
- Direct sales through tendering

CHANNELS

- Dealers – via KSCMFL,
- Retailers via KAIC
- Distributor via Department of Agriculture and Horticulture
- Direct service
- Direct sale

CUSTOMER SEGMENTS

- Rural and urban farmers, government institutions (sericulture, horticulture, forestry), plantations, urban households, nurseries, floriculturist
- Firms and municipal agencies
- Rag pickers

COST STRUCTURE

- Investment cost
- Annual operating cost
- Transportation and loading of products sold
- Profit share to BBMP, KAIC, KSCMF

REVENUE STREAMS

- Revenue from sale of 3 varieties of organic fertilizer
- Consulting revenues
- Sales from inorganic products (metal scrap), lease rental, tender forms fees

SOCIAL & ENVIRONMENTAL COSTS

- Decreased land and property value where compost plant is sited
- Possible human health risk while handling MSW
- No clear disposal mechanism for leachate from composting process

SOCIAL & ENVIRONMENTAL BENEFITS

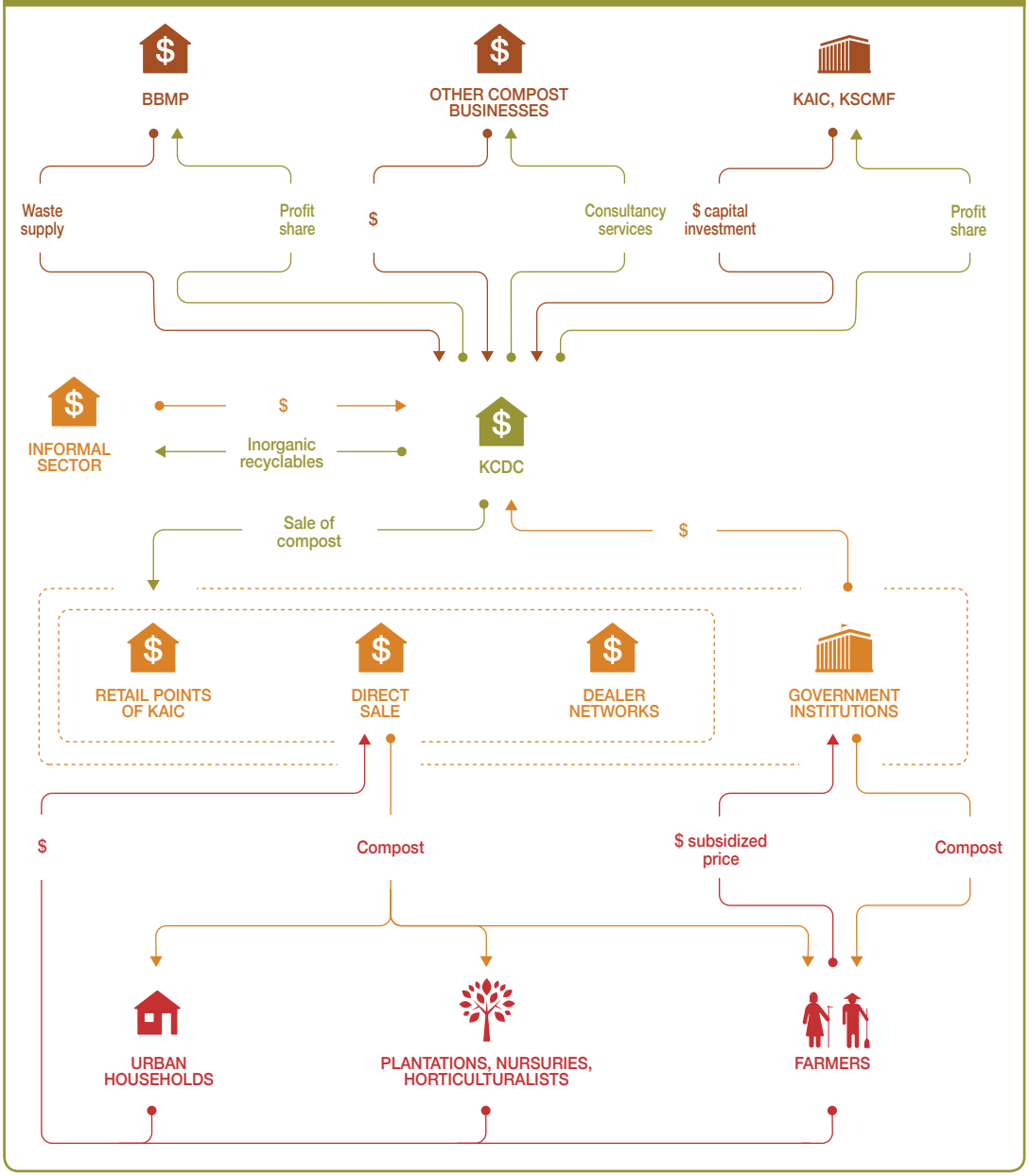
- Reduced waste disposal and contamination of water bodies
- Reduced existing waste management costs (Bangalore municipal corp. provides tipping fee to the various waste management contractors. KCDC does not charge a tipping fee there by reducing the waste management cost)
- Reduced human exposure to untreated MSW
- Reduced human exposure to chemical pollutants in farming and reduced leaching of fertilizer into water bodies
- Contribution to agricultural sector via enhancing soil fertility and productivity
- Reduced GHG emissions
- Employment generation

to farmers as they get what they are paying for, but also for compost businesses as they are able to build their product brand.

Technology and processes

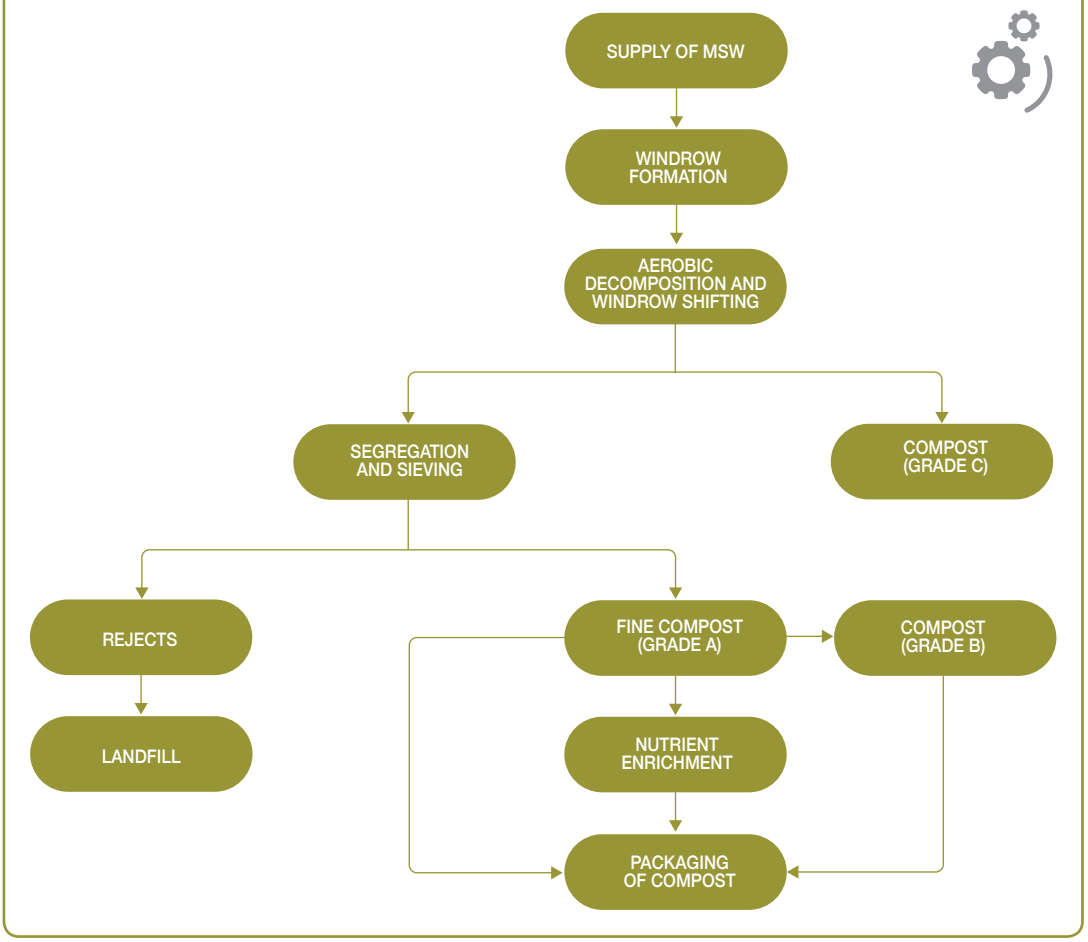
KCDC had initially adopted the mechanical composting process that was developed essentially for western nations but after much experimentation, it adopted a simple, economical and rapid aerobic decomposition method which essentially consists of the rapid decomposition of organic materials in the presence of oxygen (Figure 151). KCDC's technology is found to be cost effective and simple. It implements two types of composting technologies: a) aerobic windrow composting; and b) vermin-composting. The aerobic windrow composting method can handle large quantities of waste as it is mostly mechanized in operation. The vermin-composting operation, on the other hand, has significant manual input requirement and is suitable for the processing of smaller quantities of organic waste. The quality of the compost and the associated price for vermin-compost is higher than that for aerobic windrow composting. The company produces both composts to meet customers demand and specification. KCDC does not conduct a detailed analysis of incoming waste. Visual assessment is done and unsuitable waste is not accepted. For the aerobic decomposition windrow method, the garbage received is arranged in windrows before segregation on the concrete platform. An inoculant is sprayed on the waste to speed up decomposition and reduce odors. The windrow is turned with augers and front end loaders once every seven days to ensure proper aeration and the aeration process continues uninterrupted. Water is sprayed as and when required depending on the moisture content of the mixture. The decomposition process is completed over a period of six to eight weeks. The decomposed mixture which has undergone sanitization and stabilization is taken up for processing by way of screening with different sized sieves. KCDC produces different intermediary and

FIGURE 150. KARNATAKA COMPOSTING DEVELOPMENT CORPORATION COMPOST VALUE CHAIN



compost products: BIOAGRO, BIOAGRO RICH, B Grade and C Grade. B Grade is the decomposed matter after 25mm sieving and C Grade is decomposed matter without sieving (which is rarely sold). BIO-AGRO is the pure form of screened compost (particle size $\leq$ 4mm) without any additives, whereas BIOAGRO RICH is enriched with micro nutrients such as Neem, Gypsum, Cow dung, Rock Phosphate and Poultry Litter. The final product is a safe (free from harmful pathogens) and high nutrient product.

FIGURE 151. COMPOSTING PROCESS DIAGRAM FOR KCDC



Funding and financial outlook

KCDC was set up in 1975 with capital infusion in the amount of Rs. 5 million from KAIC (51%), BBMP (24.5%) and KSCMF (24.5%). These entities are government bodies and have invested in KCDC to promote effective waste handling and supporting usage of organic compost in agriculture. In 2000, KCDC received a grant subsidy of Rs. 2 million from the Government of India to further expand its activities to set up a bio-fertilizer plant. KCDC generates revenue by sale of compost and consultancies. Bangalore City Corporation does not pay any tipping fees to KCDC for processing the city's waste. KCDC manages its operations and maintenance on its own funds. The quantity of waste processed and sales have doubled in the last year. The quantity of sales was around 8,000 tons per year for last few years but has doubled up to about 15,000 tons from 2012 onwards. KCDC had revenues of about Rs. 51 million and an expenditure of Rs. 54 million. KCDC has been incurring losses from 2009–2012 due to the company having to adopt an aggressive pricing strategy to increase the quantity of compost sold. The quantity of compost sold has been significantly growing, doubling between 2010–2011 to 2011–2012 and with a similar trend in 2012–2013 (Table 38). The company reduced its losses in 2013 from Rs. 4.3 million to 0.6 million by increasing the quantity of processing and sales, and thereafter averaging annual profits of Rs. 1–3 million.

TABLE 38. FINANCIAL DATA FOR KCDC FROM 2009–2012

ITEMS	2009–10	2010–11	2011–12
Quantity of compost sold (in metric tons)	8,760	8,060	15,333
Total revenue (in millions of Rs.)	20.4	15.9	51.6
Total expenditure (in millions of Rs.)	19.1	20.4	54.5
Operating Profits (in millions of Rs.)	1.3	(4.4)	(2.9)
Profit after tax/(Losses)	(1.38)	(4.3)	(0.67)

Socio-economic, health and environmental impact

KCDC provides direct employment to about 40 personnel and indirectly about 60 personnel involved in the transportation and distribution of organic compost. In addition, KCDC is helping address the city's waste management problems and creating value out of the waste which was environmentally hazardous. KCDC started running as a profitable firm with average annual profits of Rs. 1–3 million and pays taxes for the consultancy services it renders to other waste reuse businesses. KCDC activities strongly support sustainable agriculture and provide advisory support to new companies and municipalities involved in waste reuse. The products of KCDC have been influential in adding value to farmers by enriching their farmland via increased microbial activity from compost use. The use of compost has also resulted in increase in crop yields. Table 39 below provides details about the economic value of organic compost considering requirement for banana crop. Typically by using organic compost, a farmer gains an economic advantage of about Rs. 6,600 per every hectare of crop. KCDC by serving about 20,000 customers per year by selling about 15,000 tons of organic compost in 2011–2012 added a total economic value of about Rs. 105 million to its consumers. The usage of organic compost in place of chemical fertilizers has also helped the country's economy by reducing imports through chemical fertilizers.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Increasing need for alternative sustainable agricultural production inputs and waste management services.
- Strong business partnerships that reduced capital investment risk and eased entry into a highly competitive fertilizer market.
- Strong commitment of state government in providing an enabling environment for marketing and distribution of the compost products.
- Policy initiatives to phase-out chemical fertilizer subsidies and capital investment subsidies for new and existing compost businesses (government schemes to augment the infrastructure for the production of quality organic and biological inputs).

TABLE 39. ECONOMIC VALUE OF COMPOST USE FOR BANANA PRODUCTION

PARTICULARS	COST IF ORGANIC COMPOST IS NOT USED	COST WHEN ORGANIC COMPOST IS USED
Quantity of fertilizer required per Ha	2 tons of chemical fertilizer	1 ton of chemical fertilizer + 2 tons of organic compost
Cost of fertilizer per hectare	Rs. 40,000	Rs. 20,000+ Rs. 6,800
Total cost of fertilizer	Rs. 40,000	Rs. 26,800
Economic benefit per hectare	–	Rs. 13,200
Economic benefit per ton of compost	–	Rs. 6,600

The KCDC model has high replication potential especially for developing countries in need of sustainable waste management approaches and environmentally-safe agricultural input alternatives. The scale of KCDC's business model is applicable to cities with population size of 1.5 million or above. Strategic partnerships and governmental support are essential at both the start-up and business development phase to mitigate capital investment risk and gain access into new markets. With chemical fertilizer companies typically owning the greatest share of the market, governmental support via price subsidies, for example, will be important to ease the entry of new compost businesses into the fertilizer market. The adopted technology is semi-mechanized and offers opportunity to use unskilled and informal labor an abundant resource in developing countries. The use of a labor-intensive and inexpensive technology also implies that the business will not require large capital investment which mitigates one of the major constraints for business start-ups especially in developing countries.

Summary assessment – SWOT analysis

Figure 152 presents the SWOT analysis for KCDC. KCDC has been particularly successful in leveraging its business partnerships to mitigate capital investment risk and gain entry into a fiercely competitive fertilizer market. Increasing governmental support along with growing demand for organic fertilizers will represent key opportunities for replication and up-scaling of the business. KCDC implements a

FIGURE 152. SWOT ANALYSIS FOR KCDC

	HELPFUL TO ACHIEVING THE OBJECTIVES	**HARMFUL** TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ Abundant and easy access to raw materials ▪ Low capital investment requirements ▪ Cost effective technology ▪ Strategic partnerships for accruing capital investments and establishing strong distribution channels, as well as enabling competitive pricing ▪ Aggressive pricing strategy ▪ Business longevity ▪ Strong brand image ▪ Extensive experience in design and operation of composting plants	**WEAKNESSES** ▪ No tipping fees for MSW ▪ Viability of business dependent on price subsidies ▪ High transportation costs given centralized operations
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Expanding to other markets – a market of about 100,000 tons of compost is achievable. ▪ Availability of financing organizations and support ▪ Government support ▪ Proactive policies and acts of government, especially toward organic agriculture	**THREATS** ▪ Competition from substitute products ▪ High seasonality of demand for compost may increase investment cost for storage facilities

segmented pricing approach where it charges peri-urban and rural farmers less than its other clients. Its pricing strategy is however dependent on price subsidies provided by the government and its removal may expose KCDC to fierce competition in the fertilizer market, in which case it would have to rebrand its product to maintain its market share. KCDC is exploring the development of a high nutrient granulated compost. This new product retains its nutrient value over a period from production to actual use that can sometimes be between three to six months. Additionally, granulation would provide stability through transportation of the product. The use of a simple technology has also been essential to KCDC's success – taking advantage of cheap and abundant labor. However, with one of the most expensive operational components of the composting business being transportation, KCDC will need to explore a decentralized production unit approach and sourcing operation to reduce its transportation costs. KCDC is an example of an innovative business utilizing a simple partnership approach to address some of the major waste management and environmental challenges in Bangalore, India.

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Michael Kropac, CEWAS, Switzerland

References and further readings

Personal communication with plant managers. 2014.

Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2014/15. As business operations are dynamic data can be subject to change.

Notes

1 Based on estimates derived by authors from secondary data on the scale of operation and data provided by the business given that KCDC was incorporated (i.e. legally established) in 1975 and accurate details are unavailable.
2 Calculations were based on the assumption that if a new project were to be set up today to handle 600 tons per day of compost, the estimated project cost would be about Rs. 350 million. Based on some of the projections done by the company, the payback period would be in the range of about seven years.
3 Exchange rate: INR (Rs.)1 = USD 0.02
4 1 lakh = 100,000; Rs. 60 lakh were in 2004–2012 about USD 120,000 and about USD 90,000 in May 2017.

CASE

Franchising approach to municipal solid waste composting for profit (Terra Firma, India)

Miriam Otoo, Lesley Hope, Sampath N. Kumar, Pushkar S. Vishwanath and Ishara Atukorala

Supporting case for Business Model 12	
Location:	Bangalore, Karnataka, India
Waste input type:	Municipal solid waste
Value offer:	Organic fertilizer, biogas, recyclable plastics
Organization type:	Public limited company
Status of organization:	Operational since 1994 (that plant was not receiving municipal waste at the time of final review in October 2017).
Scale of businesses:	Processes 1,400 tons of waste per day
Major partners:	Bruhat Bengaluru Mahanagara Palike (BBMP) – Bangalore municipality, Coromandel Fertilizer Limited, Karnataka Antibiotics and Pharmaceuticals Limited, Rallis India Limited

Executive summary

Terra Firma Biotechnologies Limited (Terra Firma) is one of the oldest operating municipal solid waste (MSW) processing companies in India. It is a public limited firm involved in the processing of MSW to organic compost, bio-methanation and the recycling of plastics and inert materials, with a processing capacity of up to 1,400 tons of municipal solid waste per day. With an increasing need for sustainable waste management options and agricultural inputs alternatives, nutrient recovery from different waste streams, particularly MSW is being promoted and showing promise in India. Terra Firma owns and operates several integrated resource recovery plants that receive MSW from the city of Bangalore. The success of Terra Firma's model rests on a multiple-revenue stream approach. Revenue is generated from five major streams: i) sales from organic fertilizer products; ii) service fees from the municipality and other private clients (townships and commercial establishment) for waste processing; iii) sales from recyclables; iv) consultancy fees; and v) franchising royalties. The diversification of their portfolio mitigates risk associated with fluctuations in demand for organic fertilizer products. Strategic partnerships have also contributed to the business' sustainability. The municipal corporation of Bangalore city and other commercial establishments and townships are contracted-out for the collection, separation and delivery of waste to Terra Firma for a fee – ensuring a consistent supply of high quality input (waste). It also partners with fertilizer companies and their network distributors to market and sell their compost whilst restricting its human resources to plant operations. These partnerships allow Terra Firma to sell compost under the fertilizer company's Coromandel brand name.

Terra Firma has also adopted a process of in-house technology development based on clear needs and locally appropriate solutions. The use of a simple and labor-intensive technology not only gives Terra Firma a competitive advantage for production, but also generates employment particularly for low-income persons who would otherwise be unemployed. Terra Firma's activities have helped to significantly reduce the city's waste management costs, reduce human exposure to untreated waste and contribute to the livelihoods of local communities.

KEY PERFORMANCE INDICATORS (AS OF 2015)						
Land use:	42 ha					
Capital investment:	USD 527,996 (additional investments have been made with scaling-up of activities)					
Labor:	215 (200 unskilled 15 skilled)					
O&M cost:	USD 1,278,807 including cost of marketing					
Output:	20,000–22,000 tons of compost per year					
Potential social and/or environmental impact:	Significant job creation, reduced human exposure to untreated waste, reduced waste management costs					
Financial viability indicators:	Payback period:	7–8 years	Post-tax IRR:	N.A.	Gross margin:	N.A.

Context and background

Established in 1994, Terra Firma set out with the goal of transforming the agricultural production landscape by promoting organic agriculture and substantially replacing chemical fertilizer use with more sustainable options such as organic fertilizers. Terra Firma noted that its business activities of converting MSW to organic fertilizers would additionally address the significant waste management challenges faced by the city. Although having the capacity to process up to about 1,400 tons per day of solid waste, Terra Firma processes about 600 tons/day of solid waste on an average and has been instrumental in reducing garbage disposal burden in Bangalore. The company was set up by a group of professionals in the area of chemical engineering and agriculture technology hailing from rural backgrounds. The activities of the company can be broadly classified into 3 parts: a) resource (nutrients and energy) recovery from the city's waste; b) consultation and design of turnkey projects; and c) franchising operations. The company set up a vermi-composting facility from municipal solid waste and has successfully operated it from 1995 to 2007. From 1998 to 2003, the company promoted franchisee operations for the processing of municipal solid waste across 38 locations in the country. In 2007, the company scaled up its operations to a new facility in a 42 hectare integrated waste management facility (ISWM). The company also undertakes training of agricultural graduates in the area of composting and other agricultural activities.

Market environment

The waste management service provided by Terra Firma to the city of Bangalore is unparalleled given the magnitude of MSW it processes daily. With increasing urban population growth and the resulting generation of significant amounts of waste, BBMP will continue to heavily depend on resource recovery businesses such as Terra Firma. Another key driver for the development of Terra Firma is related to the high demand for organic fertilizers for agriculture. The extensive use of chemical fertilizers has degraded the soil to a great extent and this has necessitated the demand for alternative agricultural inputs to replace synthetic fertilizers. With increasing farmers' awareness of benefits accruing from organic fertilizer use from government programs and increasing fertilizer prices, a surge in demand has been observed in Karnataka and neighbouring states. Although demand for organic fertilizer – compost is seasonal, with a few number of existing players in the organic compost sector, market demand in

Karnataka and neighbouring states still exceeds supply. Additionally, the recovery of biogas represents a revenue-generating opportunity for Terra Firma in the instance where it generates power in excess of its own energy and power requirements, which can be sold to the electricity grid. Given the shortage of electricity supply in Karnataka and India as a whole, there is a growing demand for alternative sources of energy production. Furthermore, with increasing national urban populations and limited waste management budgets, the demand for waste management solutions in other states and cities in India is growing as is the demand for consultation and design services for turn-key waste reuse projects by businesses like Terra Firma. The current market environments for Terra Firma's business activities are very supportive for its sustainability and indicates a foreseeable up-scaling their operations.

Macro-economic environment

Chemical and synthetic fertilizers are highly subsidized in India and this has not only led to inefficient use by farmers and high costs to the government; significant soil degradation has also been observed as a result. Even with the promotion of bio- and organic fertilizers via local research institutions and businesses, chemical fertilizer subsidies continue to be one of the key barriers for entry of organic fertilizer producers into the fertilizer market. With a growing need to increase the availability and quality of bio-fertilizers and composts in the country to improve agricultural productivity while maintaining soil health and environmental safety, the Indian government has set up a scheme to augment the infrastructure for production of quality organic and biological inputs.

A capital investment subsidy scheme for compost production has been introduced under the National Mission for Sustainable Agriculture (NMSA). The scheme provides 100% financial assistance to state governments and government agencies up to a maximum limit of about USD 300,000 per construction unit, and for individuals or private companies up to about USD 100,000 per unit (max 33% of project costs) through the National Bank for Agriculture and Rural Development (NABARD). Moreover, the Government of India is providing a Market Development Assistance of about USD 23.4 per metric ton to fertilizer companies for sale of city waste compost (Ministry of Agriculture, 2017).

Business model

Figure 153 provides an overview of Terra Firma's business model, which is centred on a multiple-revenue stream approach. Revenue is generated from five major streams: i) sales from organic fertilizer products; ii) service fees from the municipality and other private clients (townships and commercial establishment) for waste processing; iii) sales from recyclables; iv) consultancy fees; and v) franchising royalties. The diversification of their portfolio mitigates risk associated with fluctuations in demand for organic fertilizer products. The value proposition of provision of a nutrient-rich compost comes from the desirable social impact of providing an environmentally safe and cost-effective alternative agricultural input to local agricultural producers. It partners with Coromandel Fertilizer Limited and other retail distribution networks for sales and marketing of their organic fertilizer products whilst restricting its human resources to plant operations. Product demonstration, proof of concept farm fields and sustained interactions with agricultural producers was instrumental in garnering market demand for their products. Another key element of their model is the provision of waste management services to the municipality BBMP and other large scale generators via the processing of their wastes for a fee. This is a win-win partnership as all parties benefit: a) municipalities save on landfill costs; b) local businesses are to comply to waste management ordinances; and c) Terra Firma generates revenues, ensuring the sustainability of the partnership. Terra Firma also implements a franchise-based approach to increase revenue streams and capture additional markets. Terra Firma has entered into franchise agreements with several enterprises all over India. By this agreement, Terra Firma provides training on the composting technology at no cost but charges a cost-price fee for method trainings on bio-fertilizers production to the franchisee. Terra Firma markets the compost produced by the

FIGURE 153. TERRA FIRMA'S BUSINESS MODEL CANVAS

KEY PARTNERS

- Bangalore municipality (BBMP)
- Coromandel Fertilizer Limited
- Karnataka Antibiotics and Pharmaceuticals Limited
- Rallis India Limited
- Waste collection and separation partners

KEY ACTIVITIES

- Production and sale of enriched organic compost
- Promotional activities to catalyze compost market demand
- Sales of inorganic materials and other recyclables
- Consulting and design of waste reuse turn-key projects
- Training of agricultural professionals
- Franchising operations
- Production of biogas (bio-methanation) for internal use
- Research and development

KEY RESOURCES

- Knowledge and experience of 18 years in MSW business sector
- MSW
- Land, infrastructure, equipment, labor
- Relationships and contract agreement with partners
- Franchising contracts
- Composting technology development
- Partner-brands

VALUE PROPOSITIONS

- Agricultural producers obtain nutrient-rich compost at a competitive price
- Local government bodies and businesses obtain recyclables (plastics) as a substitute for bitumen
- Provision of sustainable waste management alternative for city and local businesses
- Provision of consulting and design services for the development of waste reuse turn-key projects and franchisees
- Reduction in power demand and expenditure due to biogas usage for internal power generation of the facility

CUSTOMER RELATIONSHIPS

- Product promotion activities through demonstration, proof of concept farm fields
- Indirect interaction with clients via network of distributors
- Direct interaction with clients
- Public-private partnerships with municipality and formal agreements with townships and commercial centres
- Recurrent partnerships for individual projects
- Dedicated one-to-one coaching and consulting services
- Self service

CHANNELS

- Distribution and retail networks (BBMP, Coromandel, KAPL)
- Direct communication and customer relationship
- Bidding (calling of tenders)
- Bidding and the word of mouth

CUSTOMER SEGMENTS

- Farmers, landlords, urban households
- Government institutions and plastic scrap dealers
- Municipal and private agencies in charge of the solid waste management, commercial institutions and townships
- Professionals in the SWM sector (potential franchisees and clients for consulting/ design and turn-key projects)

COST STRUCTURE

- Land and infrastructure: USD 4,589,675 to 4,956,849
- Material inputs: USD 17,624
- Marketing costs: USD 475,673.92
- Manufacturing costs: USD 392,325.42
- Administrative expenses: USD 206,351
- Interest and finance charges: USD 292,086.92
- Savings from in-house energy production
- Waste collection and separation fees
- R&D

REVENUE STREAMS

- Sales of organic fertilizer products
- Service fees from the municipality and other private clients (townships and commercial establishments) for waste management services
- Sales from recyclables
- Consultancy fees
- Franchising royalties

SOCIAL & ENVIRONMENTAL COSTS

- None noted based on information provided by business

SOCIAL & ENVIRONMENTAL BENEFITS

- Reduced existing pollution of water bodies
- Reduced existing waste management cost for the municipality
- Reduced human exposure to untreated waste
- Job creation for the poor without any gender discrimination
- Contribution to restoring degraded soils and food security
- Savings in landfill area

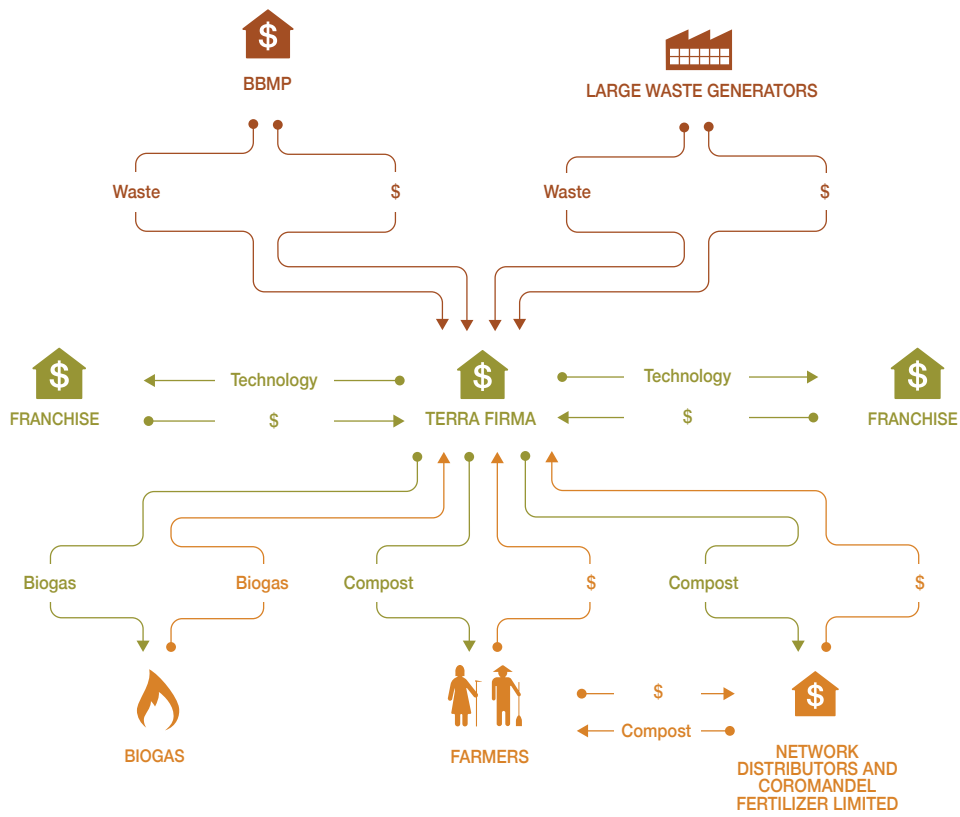
franchisees through a partner – Rallies India. In return, Terra Firma retains 24 percent of the equity with the franchisee and 10 to 20 per cent of the profit margin goes to the franchisee. Additionally, Terra Firma produces biogas, which is used internally to reduce production costs. Labor is employed on contractual terms to further reduce production cost especially during low production periods as well as when they are not in production. Terra Firma has established and demonstrated that it is possible to run a waste business sustainably over a long period based primarily on non-municipal tipping fee revenues. The company provides employment to about 200 people at its facility and about 15 people for management and administration. The indirect employment for transport, dealers, distributors and waste recycling industry supported is estimated to be at least twice these numbers.

Value chain and position

The City of Bangalore generates about 3,500 tons of waste per day. Like most cities in India, Bangalore faces a huge challenge in processing all the waste generated in the city. Terra Firma has a supply contract agreement with Bruhat Bengaluru Mahanagara Palike (BBMP) for supplying a minimum of 600 tons of waste daily. There is no short to medium term threat about availability of waste as a raw material to Terra Firma or to any other waste processing facilities in Bangalore. Terra Firma additionally has an independent collection system from large waste generators like commercial establishments (hotels, industries, institutions) and residential townships for their solid or organic waste. About 25–30% of the capacity is collected from these sources. This partnership ensures continuous waste (input) supply thus mitigating any production risk associated with input supply. Terra Firma also partners with Coromandel Fertilizer Limited and other network distributors to market its compost. This partnership allows Terra Firma to sell compost under Coromandel's brand name. Terra Firma has invested in

product demonstrations and proof of concept farm fields to penetrate the fertilizer market and create a niche for itself. Currently, it serves between 35,000 farmers annually. It competes with other organic as well as chemical fertilizer producers. The organic fertilizer produced by Terra Firma is lower in price and thus has a competitive advantage over other organic fertilizers however highly subsidized chemical fertilizer still represents a great threat. Existing players in the organic fertilizer sector are currently unable to meet market demand in Karnataka and neighbouring states; and the demand is expected to grow in the near future; thus great opportunities exist for Terra Firma to increase its market share. Additionally, increasing urban populations and related waste management challenges along the promotion of integrated resource recovery facilities suggest that municipalities in India will continue to demand consultancy services of business like Terra Firma for the establishment of waste reuse turnkey to projects. Figure 154 above provides a diagrammatic overview of Terra Firma's value chain.

FIGURE 154. TERRA FIRMA'S COMPOST VALUE CHAIN



Institutional environment

Terra Firma is a public company registered under the Indian Companies' Act of 1956. The company has more than 50 shareholders. Waste processing facilities are usually not accepted by communities due to visual, odor and traffic pollution. This issue snowballed into a political, social and cultural resistance. It has been necessary for Terra Firma to manage the socio-political environment on an ongoing basis. It has garnered local support with its community works and corporate social responsibility. Terra Firma has also generated employment to large number of local residents near the facility.

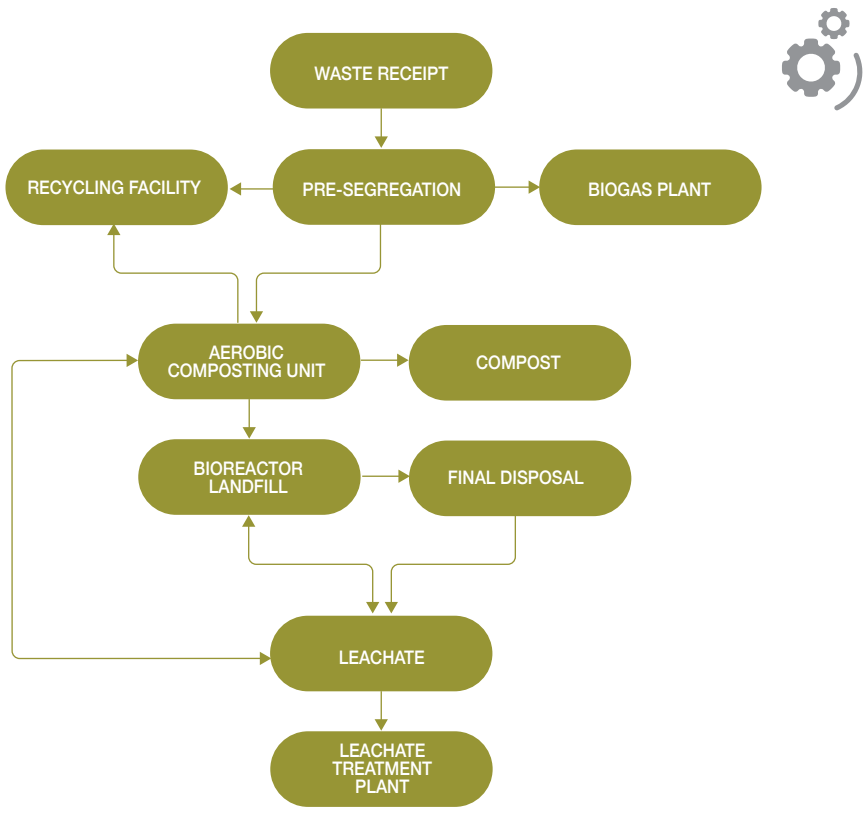
Technology and processes

Terra Firma developed their technology for treating MSW in house (Figure 155). All developed technologies meet the requirements of environmentally, safe waste handling processes and being cost effective to ensure business viability. The company started with the vermi-composting of organic waste, then as it started receiving mixed waste, a microbial culture based waste composting method was adopted. As the waste included plastics, new techniques for plastic cleaning and conversion were incorporated. Terra Firma receives an average of 1,400 tons of MSW per day. About 650 tons of this waste is treated in the aerobic composting facility and 350 tons utilized for bio-methanation purposes daily. The remaining waste is sent to the bioreactor landfills.

1) **Composting –** An aerobic windrow composting process is used for the treatment of the organic waste. After the unloading of the waste, water is sprinkled on the waste to achieve a desired moisture level. The waste heap is then pushed by a tractor blade or front-end loader, which is used make high heaps of the waste, which is then sprayed with water and formed into a minimum of three meters heaps (maximum height five meters). A cow dung solution or bio-culture act as a catalyzing agent and accelerates the process. The heap is then turned by tractor blade or front-end loader into another windrow to allow aeration. This process is repeated after another seven to ten days. At the end of the three to four weeks period, the green or fresh compost may have fully decomposed but not the cellulosic content. The mixture is, therefore, stored in large sized windrows under a covered/roofed area for maturation for four to eight weeks. The mixture is then sieved to meet client requirements.
2) **Bio-methanation –** The bio-methanization of organic wastes is accomplished by a series of biochemical transformations. In the first step hydrolysis, acidification and liquefaction take place and in the second step acetate, hydrogen and carbon dioxide are transformed into methane. At Terra Firma, all these reactions take place simultaneously in a single reactor.
3) **Recycling of inorganic materials –** Metals, plastic, glass and paper separated, cleaned, packaged and sold.
4) **Bioreactor landfills** – The bioreactor landfill technology is an accelerated process of decomposition of municipal waste in the landfill. This technology involves placing the waste in specially designed cells. The cells have provision for leachate collection and recirculation. As one cell gets filled, it is covered and closed with an impervious liner. Gas extraction pipes are placed. The leachate from the landfill and the bio-methanation effluents are sprayed / injected to accelerate the bio-methanation process. The degradation time is reduced from about 10–15 years to about two to four years. Subsequent to the gas extraction the inert waste is removed from the landfill, compost and other recyclables are mined and the balance materials are sent for final disposal in a sanitary landfill.
5) **Final disposal** – The final disposal is proposed in a sanitary landfill. The incoming waste is spread in thin layers and compacted using landfill compactors to achieve high density of the wastes. The waste is covered immediately or at the end of each working day with a minimum of 10cm of soil, inert debris or construction material. Prior to the commencement of the monsoon season, an intermediate cover of 40–65cm thickness of soil is typically placed on the landfill to ensure proper compaction and prevent soil infiltration during monsoon.

The technologies developed by Terra Firma are focused on cost-effectiveness within the regulatory frameworks. The outputs of the company have been tested and approved by the regulatory authorities and are acceptable by the clients. But there are technological constraints with the changing nature of municipal solid waste; there is a significant quantity of waste which cannot be processed. The company is now facing issues on managing large amounts of inert materials, about 15% of the waste received (100 tons per day). The conventional method of sanitary landfill would exhaust the land

FIGURE 155. PROCESS FLOW CHART AT THE TERRA FIRMA-GUNDLAHALLI INTEGRATED SOLID WASTE MANAGEMENT FACILITY



very quickly, thus the company is exploring new technologies for processing this waste including converting them into refuse derived fuels and panel blocks.

Funding and financial outlook

The capital investment for the company was through equity infusion from diverse sources including private financiers, the municipality, in a total amount of USD 6,237,402. Of this amount, the municipality contributed USD 366,906 at no interest as an advance against tipping fees. Terra Firma uses working capital loans from banks and its own financial resources to cover operational and maintenance costs. Terra Firma generates revenue via five streams: a) sale of MSW-based organic fertilizer; b) waste management fees; c) sale of recyclables; d) consultancy fees; and e) franchise royalty fees. Of the total revenue, sales from compost contribute the most, that is, USD 770,000 per annum followed by sales from recyclables mainly plastics. Tipping fees of USD 280,320 per annum contribute the least. Terra Firma has been making profit since its inception, except the financial year 2009–2010 (a loss of about USD 352,435). The company was scaling up its operations at a new facility and incurring additional investment costs in the process. Table 40 below provides the percentage contributions of total revenue and expenditure. It is noted that administrative expenses including maintenance of the facility, utilities, rent, salaries to the staff is the highest contributor to the expenses.

TABLE 40. TERRA FIRMA'S REVENUES AND EXPENDITURES EXPRESSED IN PERCENTAGES

ITEM NUMBER	COMPONENT	
A	**Revenues**	**Percentage of total revenue**
1	Sale of compost	41%
2	Other revenues	59%
B	**Expenditure**	**Percentage of total expenditures**
1	Raw material consumed	20%
2	Manufacturing expenses (includes labor charges)	24%
3	Administrative expenses (includes rent and utilities)	36%
4	Selling and distribution	18%
5	Interest and financing charges	1%
6	Depreciation and other charges	1%

Socio-economic, health and environmental impact

Terra Firma has established and demonstrated that it is possible to run a waste business sustainably over a long period based on non-municipal tipping fee revenues. The company is a leading example in support of privatizing the municipal solid waste business to maximize recovery of resources from waste. The company influences a series of economic activities as part of its process. The polluter pays principle is implemented via direct payments to Terra Firma by large waste generators for the management of their waste. The transport sector is organized to collect and transport over larger distances in an efficient way thereby setting standards for similar operations. The concept of component-wise treatment of waste using smart segregation strategies has been exemplified by the company. The economic valuation of the enterprise can be assessed from its internal economic activities. Terra Firma set up the plant facility on its own land which in itself is trend setting in India, reducing the burden on the municipal agencies for provision of land to solid waste management operators. The company provides employment to about 200 people at its facility and about 15 people for management and administrative purposes. The indirect employment for transport operators, dealers, distributors and waste recycling industries supported is at least twice the current number of total employees. Terra Firma's activities additionally will in the long term reduce chemical fertilizer imports, resulting in foreign exchange savings. Averted greenhouse gas emissions and groundwater contamination from indiscriminate waste disposal are among the additional benefits of Terra Firma's activities.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Strong business partnerships that reduced capital investment risk and eased entry into a highly competitive fertilizer market.
- Solid multi-revenue stream based business model that mitigated initial risk associated with fluctuations in market demand.
- Marketing strategies based on product demonstrations and proof of concept farm fields garnered the market demand for their organic fertilizer products.
- Increasing need for alternative sustainable agricultural production inputs and waste management services.
- Increased awareness among farmers about the advantages of organic fertilizers and in the face of increasing fertilizer prices.
- Strongly increasing urban populations and associated MSW problem.

Terra Firma's model has a high replication potential especially in large urban areas facing solid waste management challenges. High initial investment costs may represent barriers for entrepreneurs in developing countries where accessing capital investment is one of the key constraints for business development. Implementation of institutional policies such as the polluter pays principle, especially for large waste generators would be essential to ensure the viability of one of its revenue streams.

Summary assessment – SWOT analysis

Figure 156 presents the SWOT analysis for Terra Firma. Its model demonstrates that waste reuse businesses can be successful without government subsidies. By diversifying its portfolio, Terra Firma mitigates risk associated with fluctuations in demand for its organic fertilizer products. It has been particularly successful in leveraging its business partnerships to gain entry into a fiercely competitive fertilizer market via using the well-established marketing and distribution channels of other companies. This marketing strategy is however highly dependent on partners, exposing Terra Firma to some buyer power risk. Terra Firma has been conducting product demonstrations and proof of concept farm fields to establish its product brand and gain some market share. Increasing governmental support along with growing demand for organic fertilizers will represent key opportunities for replication and up-scaling of the business. Local community support programs may help dissipate occasional community

FIGURE 156. SWOT ANALYSIS FOR TERRA FIRMA

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ Well-established multiple revenue streams ▪ Good local buy-in for products due to establishment of brand name ▪ Strong and strategic business partnerships ▪ Independent decentralized franchisee operations ▪ Reduced production costs due to generation of energy for internal use	**WEAKNESSES** ▪ High capital investment ▪ Operational pulls and pressures by municipal authority in waste supply which result in management issues of waste ▪ Marketing strategy currently highly dependent on fertilizer companies
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Absence of other key competitive organic fertilizer suppliers in the market ▪ Up-scaling potential of CDM project to earn carbon credits ▪ Tax free policy for organic fertilizer in India ▪ Production and sale of refuse-derived fuels ▪ Sale of electricity to national grid from increased production	**THREATS** ▪ Possible human health risk of being exposed to waste at collecting, sorting and processing ▪ Village protest against frequent waste transportation across their village ▪ Chemical fertilizer subsidies hamper organic fertilizer growth

protests against waste transportation through community neighbourhoods. Several opportunities exist for Terra Firma to further expand its operations. These include: a) the production and sale of refuse-derived fuels; b) sale of excess electricity to national grid; and c) the establishment of a CDM project for sale of carbon credits. Terra Firma is an example of an innovative business utilizing a multi-revenue approach and strategic partnerships to address some of the major waste management and environmental challenges in Bangalore, India whilst generating significant profits and benefits to society.

Contributors

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Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2015. As business operations are dynamic data can be subject to change. At the time of final review (October 2017), for example, the plant was noted to not be receiving municipal solid waste.

CASE

Socially-driven municipal solid waste composting for profit (Waste Concern, Bangladesh)

Miriam Otoo and Lesley Hope

Supporting case for Business Model 12	
Location:	Dhaka, Bangladesh
Waste input type:	Municipal solid waste (MSW)
Value offer:	Efficient waste management service and provision of high quality compost
Organization type:	Private (Social Business Enterprise)
Status of organization:	Operational since 1995
Scale of businesses:	Small to medium scale: 3–20T of organic waste per day Large scale: 75–100T of organic waste per day
Major partners:	Dhaka City Corporation (DCC), Ministry of Environment and Forest (MoEF), Sustainable Environment Management Programme (SEMP) of the UNDP

Executive summary

Waste Concern Group, established in 1995, is a Social Business Enterprise (SBE) comprising both 'For Profit' and 'Not-for Profit' enterprises with the vision to contribute towards waste reuse, environmental improvement and poverty reduction through job creation and sustainable development. Waste Concern works in partnership with the government, private sector, local communities and international agencies. Amongst its various lines of business activities, the key ones are solid waste management and resource recovery where compost production plays an essential role. Waste Concern's compost business models implement both a small-to-medium decentralized community-based approach and large scale CDM (Clean Development Mechanism)/carbon trading approach. Waste Concern has been particularly successful by forging strategic partnerships with the local government, private enterprises and community-based organizations to optimize the allocation of resources and activities, reduce risk associated with high capital investments and establish an assured market for their product. The local government gave Waste Concern legal access to the city's waste and provided land for the plants. This is a win-win partnership as by alleviating Waste Concern of its high initial investment costs, the municipality gains from reduced waste collection and landfill costs. Waste Concern earns revenue through its established door-to-door collection service by means of rickshaw vans for which households pay a nominal amount of between USD 0.14 to 0.57 depending on income levels.

Additional revenue is generated from compost sales and carbon trading on international markets. Compost is sold in bulk to private chemical fertilizer companies who rebrand and sell through their own marketing and distribution networks. This sales strategy ensures an assured, large and growing market base for Waste Concern's compost. Waste Concern's extensive business activities has created a value chain generating thousands of jobs among the urban poor particularly women; and has also contributed to reducing greenhouse gas emissions by 62,200 tons between 2001 and 2006 (excluding the CDM project). This local business has reduced solid waste management expenditures and saved landfill area.

KEY PERFORMANCE INDICATORS (AS OF 2012)				
	SMALL SCALE		MEDIUM SCALE	LARGE SCALE
Scale of production (quantity of waste processed):	3 tons/ day	10 tons/ day	20 tons/ day	700 tons/day
Land use (square meter):	468	1,338	2,341	N.A.
Capital investment (USD):	14,609	41,739	73,043	16,500,000
O&M cost (USD):	4,348	14,493	28,986	N/A
Output (tonnes of compost/day)	0.75	2.5	5.0	130.0
Potential social and/or environmental impact:	Value chain generated approx. 1,000 jobs among urban poor; reduced GHG emissions by 62,200 tons between 2001 and 2006; 13.4 ha of savings in landfill area			800 jobs created; reduction of 89,000 tons of GHG emissions [as of 2012, 150 jobs created and reduction of 34,200 tons of GHG emissions]
Financial indicators:				
Pay Back period (years)	2	1.71	1.5	-
Post-tax IRR	N.A.	N.A.	N.A.	N.A.
Gross margin	8,696	28,986	57,971	N.A.

Context and background

The city of Dhaka, the capital of Bangladesh, produces about 4,700 tons of solid waste per day. The Dhaka City Corporation (DCC) is responsible for managing the waste; however with an ever-shrinking waste management budget and unavailability of landfill sites, it is only able to collect less than 40% of the total waste. As a result, waste is dumped in open areas and unmanaged landfill sites, creating many serious threats including diseases, intolerable odor, contamination of water sources, emission of greenhouse gases and exposing the rag-pickers to hazardous waste. In view of the then-prevailing problem, two young and dynamic urban planners, Iftekhar Enayetullah and Maqsood Sinha, founded Waste Concern, initially a research-based non-governmental organization (NGO) in the field of waste management and environment. Waste Concern is mainly involved in collection and processing of municipal solid waste (MSW) into compost and marketing thereafter. It began its composting operations in 1995 on an experimental basis in a small area of 1,000m^2 lent to it by the Lions Club for a period of three months. This demonstration project was to explore the technical and commercial feasibility of the labor-intensive aerobic composting technique. It also adopted door-to-door collection of waste with the help of rag pickers by providing them with rickshaw vans. This activity started by covering 100 households which subsequently increased to 600 households by 2004. At the time of the study, the service was extended to 1,400 households by partnering with community-based organizations. Waste Concern has set an example for a successful decentralized community-based waste management business. Using an appropriate composting technology in combination with sound financial management, as well as an appropriate marketing strategy ensures high quality compost and

constant sales throughout the year. This model is already been replicated in 27 cities of Bangladesh and 10 cities of other developing countries with the support form external support agencies as well as local entrepreneurs. In 2005, to scale up its model with private investment, Waste Concern in partnership with a Dutch recycling company called World Wide Recycling BV initiated a project where carbon trading has been harnessed. This is the world's first compost plant using CDM opportunity.

Market environment

Huge amounts of waste are generated daily in the city of Dhaka, which the Dhaka City Cooperation has found difficult to manage. Indiscriminate waste disposal and unmanaged landfills spurred Waste Concern's desire to enter into a partnership with both private and public organizations to process MSW into organic fertilizers for agricultural purposes. While this initiative addressed the imminent environmental and social challenges, the production of compost represented a valuable agricultural input alternative for farmers. The extensive use of chemical fertilizers has degraded the soil to a great extent and an alternative to successfully replace synthetic fertilizers was a necessity and Waste Concern compost with value addition by MAP Agro filled this gap and made for the correct type of replacement for chemical fertilizers. Additionally, the growing popularity of industrial poultry farming in the country also created an increasing opportunity for compost as poultry feed. An approval from the Bangladesh Agriculture Research Council for the suitability of the compost product for agricultural purposes and policy support from Ministry of Agriculture was essential for market acceptance.

Macro-economic environment

With an estimated population of 291 million by 2050 in Bangladesh, total rice demand is expected to reach 68 million tons, which is more than twice that compared to 2007. To match this anticipated spike in agricultural production, chemical fertilizer application and demand are expected to reach an all-time high (Basak, 2014). Government provides subsidies on chemical fertilizer for agricultural producers which accounts for about 6% of total public expenditure. Farmers have generally been found to use chemical fertilizers indiscriminately without adequate information on actual soil and plant requirement. Over-application is common and this has resulted in depleted soils and a decline in crop yields. The use of organic fertilizers will play a vital role in restoring soil fertility and improving crop productivity. Policy instruments to address market price distortions created by the current subsidies on chemical fertilizers will be imperative to catalyze business development in the organic fertilizer market. A detailed analysis of the policy environment was provided by Matter et al. (2015).

Business model

Figure 157 represents Waste Concern's business model canvas. Using strategic partnerships that engage both public and private entities, Waste Concern's compost business models implement a small-to-medium decentralized community based approach and large scale CDM/carbon trading approach. This figure presents an aggregate of both the small-to-medium decentralized community based approach and large scale CDM/carbon trading approach. As a key characteristic of their business model, Waste Concern has forged strategic partnerships with the local government, private enterprises and community-based organizations (CBOs) to optimize the allocation of resources and activities; reduce risk associated with high capital investments and establish an assured market for their product. At the start-up, development agencies such as UNDP, UNICEF and CIDA provided both financial and expertise support for smooth operations of the business. Research institutes (universities) did and continue to provide periodic quality testing of the finished compost for which the services are paid for by Waste Concern. The local government provided land for the composting plants and gave Waste Concern legal access to the city waste. In alleviating Waste Concern's initial investment costs, the municipality gains from reduced waste collection and landfill costs. Whilst Waste Concern has a

FIGURE 157. WASTE CONCERN BUSINESS MODEL CANVAS (INCLUDING BOTH THE COMMUNITY-BASED AND CDM COMPOSTING MODELS)

KEY PARTNERS

- Dhaka City Corporation (DCC)
- Ministry of Environment and Forest (MoEF)
- UNDP
- Private chemical fertilizer companie
- Local communities and community-based organizations (rickshaw van operators)
- CDM Board

KEY ACTIVITIES

- Collection of municipal solid waste, also door-to-door
- Segregation of waste
- Processing of MSW to organic compost
- Sale of compost and carbon credits
- Quality control
- Awareness campaigns
- CER administration activities

KEY RESOURCES

- Right to collect city's MSW
- Land
- Capital
- Labor
- Contract partnership agreement with municipality
- CDM registration, certification etc.

VALUE PROPOSITIONS

- Provision of safe and nutrient-rich organic fertilizer (valuable substitute for chemical fertilizer)
- Provision of waste management services including door-to-door
- Provision of certified Reduction of greenhouse gas emissions

CUSTOMER RELATIONSHIPS

- Direct interaction and personal help with clients
- Contract agreement with municipality

CHANNELS

- Direct and bulk sales to fertilizer companies
- Contract agreement
- Direct sale

CUSTOMER SEGMENTS

- Both rural and urban farmers
- Fertilizer trading companies (MAP Agro industries, Alpha Agro Ltd.)
- Municipality (local government)
- International carbon-credit clients

COST STRUCTURE

- Capital investment ranging from USD 14,000–16.5 million depending on composting capacity
- Operation and maintenance

REVENUE STREAMS

- Sale of compost
- Household waste collection fees
- Sale of Carbon emission reductions through CDM

SOCIAL & ENVIRONMENTAL COSTS

- None noted with available data

SOCIAL & ENVIRONMENTAL BENEFITS

- Reduced human exposure to untreated waste
- Possible reduction in human health cost in the locality due to reduction of pollution
- Significant job creation for the poor without any gender discrimination
- Reduction of greenhouse gas emissions
- Reduction in soil degradation with adoption of organic compost for agricultural production

legal permit from the DCC (main governing body in charge of managing waste) to access and process municipal waste in Dhaka, it does not have exclusive rights (own) to the waste and thus there remains the risk of facing competitors (e.g. compost producers) for the waste input. However, with over 4,700 tons of waste generated daily in the city and DCC limited capacity to properly manage only 40% of the waste, risk associated with input (waste) supply is relatively low. Community-based organizations are contracted for the collection and separation of waste, which ensures a consistent supply of high quality waste input for Waste Concern and income for the CBOs. Waste Concern earns a revenue through the established door-to-door collection service by means of rickshaw vans by the CBOs for which households pay a nominal amount of between USD 0.14 to 0.57 depending on income levels.

Municipal solid waste is processed into compost and sold directly in bulk through an established countrywide marketing and distribution system of private chemical fertilizer companies such as MAP Agro, providing an assured and large market base for their product. On the other hand, without established marketing and distribution channels, Waste Concern faces a strong buyer power as they mainly sell their compost to price-setting private chemical fertilizer companies who rebrand and sell the compost product. To reduce buyer power risk, Waste Concern launched an information campaign using farm demonstrations to raise consumer awareness and product demand. Waste Concern is negotiating with other large bulk compost users to limit their dependency on their main customer – MAP Agro Fertilizer. This has been an important strategy to also increase their direct market share as substitute products (e.g. other organic fertilizer products and chemical fertilizers) continue to flood the market. The threat of new business entrants is very high as there is an increasing availability and unlimited access to the waste input. Waste Concern, however, has an edge over new entrants given its strong partnerships across public and private sectors and communities, which is essential to mitigate many of the market risks it faces.

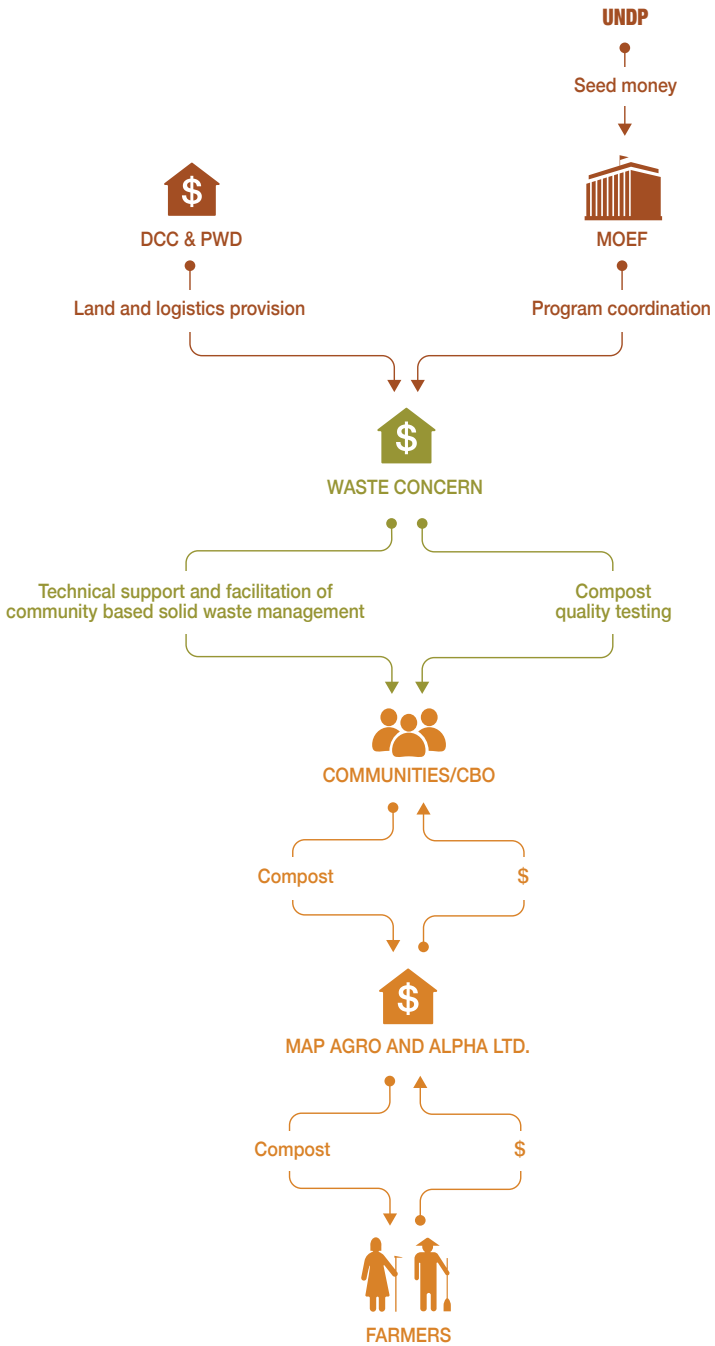
Value chain and position

Waste Concern's business operations cover the entire MSW value chain, providing services from collection to processing of the waste. Its activities have been implemented under two main business models namely:

a. Partnership model of community-based composting

Waste Concern's initiatives combine both public and community spheres with private sector involvement (Figure 158). Seed money from UNDP in partnership with the Ministry of Environment and Forests, Dhaka City Corporation (DCC) and Public Works Department (PWD) were utilized to implement community-based, solid waste management projects. A key characteristic of Waste Concern's community-based composting model is that it can be adapted to many contexts both in urban and rural areas. It has also shown great potential for implementation in slum areas at a small-, medium- or large-scale. The small-scale model processes three tons of organic waste daily, with the medium- and large-scale models processing three to 10 tons and more than 11 tons of organic waste per day, respectively. By focusing its efforts on the city's slums, an area where more than a third of the city's 11 million people live, Waste Concern has created a system that allows the community not only to dispose of trash effectively but also helps them to raise money. The organizational set-up of the composting scheme follows a business approach, which means that the community is seen as client who is paying for the service of waste collection. Waste Concern earns revenue through its established door-to-door collection service by means of rickshaw vans with capacity of 1.18m^3 for which households pay a nominal amount of between USD 0.14 to 0.57 depending on income levels. Waste Concern largely sells its compost in bulk to private chemical fertilizer companies such as MAP Agro Fertilizers, who rebrand and sell the compost through their established countrywide marketing

FIGURE 158. WASTE CONCERN VALUE CHAIN – PARTNERSHIP MODEL OF COMMUNITY-BASED COMPOSTING UNDER SEMP

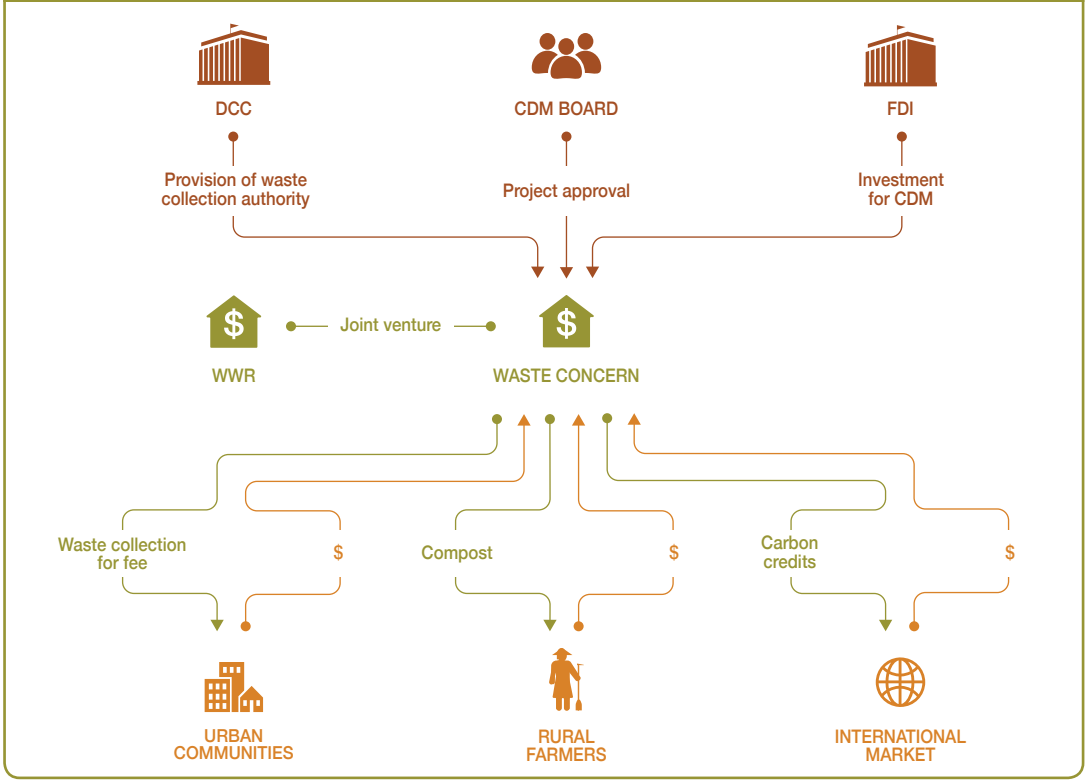


and distribution system. This partnership provides access to an assured, large and growing market base for Waste Concern's compost, selling about 10,000 tons of organic fertilizer per year (2010), which represents a significant portion of the market. This marketing strategy mitigates competition risk that they would otherwise face with chemical fertilizers. The community-based composting scheme has an added benefit for the communities of Dhaka in that they share in the profits made in selling the compost, earning USD 0.09 per kilogram. This model has improved the livelihoods of community members as the compost collectors come from the community and earn up to USD 52 per month[1]. The sustainability of this model is grounded in strong partnerships and the assured benefits accruing to each partner.

b. Composting under CDM/carbon trading model

Waste Concern has also established the world's first CDM compost plant in Bangladesh. This carbon trading-based business model is based on strong partnerships between the public, private and community spheres (Figure 159). Waste Concern partners with the Clean Development Mechanism's Board, which approves a compost plant project owned as a joint venture by Waste Concern and World Wide Recycling (WWR). Dhaka City Corporation (DCC) provides the approval for the collection and processing of the city's waste by Waste Concern. The compost plant obtains organic waste from the urban population through direct collection from vegetable markets. The resulting higher-yield, lower-cost compost is sold to rural farmers, and the carbon credits obtained are sold on the international market. A key characteristic of this model is that the municipality does not bear any cost with the setup of the project. Waste Concern collects all waste free of charge; and also bears

FIGURE 159. WASTE CONCERN VALUE CHAIN – CDM/CARBON TRADING SUPPORTED COMPOSTING



the cost for the land of the compost plant. This model saves the city numerous costs associated with waste collection, transportation, and disposal. The plant has two major sources of revenue: one is compost (organic fertilizer), and the other is Certified Emission Reduction (CERs)[2]. The compost plant processed between 75–100 tons of organic waste on a daily basis between 2009 and 2010. By 2012, the project had processed 76,697 tons of organic waste and generated 34,200 CERs. In addition to reducing greenhouse gas emissions, this model also generates valuable carbon credits on the international market. This project has improved livelihoods in the community, creating 150 direct jobs for the poor, with these jobs cutting across the entire MSW value chain from compost plant operation, transportation of waste and in the distribution of compost. This model is grounded in a win-win partnership between key players and has been instrumental in attracting large amounts of foreign direct investment (FDI) in the area of organic composting and carbon trading using the Clean Development Mechanism (CDM) of the Kyoto Protocol.

Institutional environment

Although the solid waste management system in Bangladesh is still not well organized, efforts are under way to improve the organizational structure for solid waste management in different cities. An example is Dhaka City Corporation which has established a Solid Waste Management Cell to improve the waste management services in the city. At the national level, the Urban Management Policy Statement, 1998 was enacted and implemented by the Government of Bangladesh, which recommends municipalities to privatize waste management services and give priority to slum areas. For more recent policy development see Matter et al. (2015). The special emphasis and encouragement of private sector participation in water supply and sanitation in urban areas is gradually resulting in the provision of efficient and reliable waste management services to the public, especially those in slum areas.

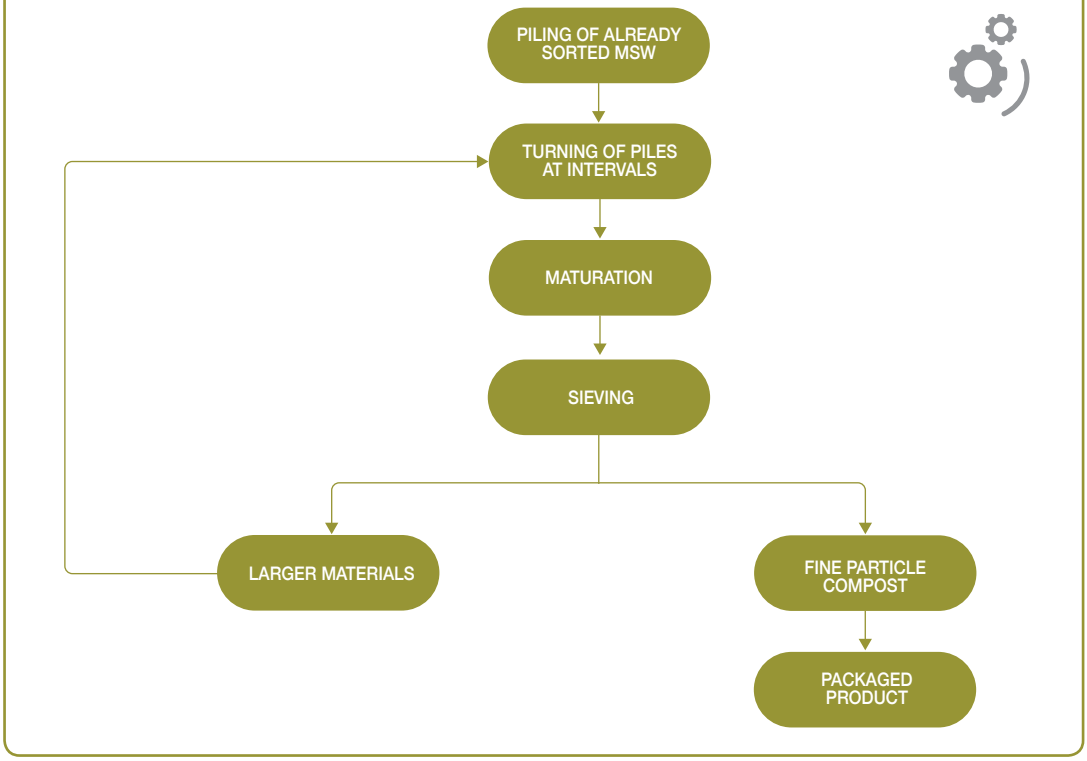
Technology and processes

A box-type composting technique was adopted because it is a low-cost process that needs less turning compared to the Indonesian Windrow Method, which was originally used (Figure 160). It has limited mechanization and is suitable for Bangladesh's climatic conditions. The composting process requires 40 days for decomposition and a maturing period of 10–15 days. Special measures are taken to reduce the odor. After maturing, the compost is screened and graded according to particle size and packed for marketing. Waste Concern has also developed two other types of composting methods apart from the Box Composting under the UNDP supported Sustainable Environment Management Programme (SEMP). These are the Aerobic Composting and Barrel Type Composting methods. All three techniques are simple, low cost and labor intensive methods which are suitable to the socioeconomic and climatic condition of Bangladesh.

Funding and financial outlook

For Waste Concern's decentralized business model, there is a range of plants across the city of different sizes and investment cost. These range from USD 14,000 to USD 73,000. The cost of maintaining and operating a plant also varies from USD 4,300 to USD 29,000 depending on the size of the plant. The company has benefited from the provision of land by the local government at no cost and financial support from Lion's Club, UNDP, UNICEF and CIDA, as well as technical guidance. Financial data was not accessible for the CDM business model. For both models, Waste Concern generally has two main revenue streams: a) compost sales; and b) carbon trading. About 31,100 metric tons of compost is sold on yearly basis yielding revenue of USD 998,621. There is the possibility of revenue generation from carbon credits for the decentralized business model. However, with a decline of the carbon market, these options have to be carefully analyzed.

FIGURE 160. PROCESS DIAGRAM OF WASTE CONCERN



Socio-economic, health and environmental impact

Waste Concern's diverse projects have created numerous direct and indirect benefits for the economy and the environment. The simple idea of converting the high organic content of the waste, into compost brought about a valuable substitute for chemical fertilizers. Overuse of chemical fertilizers has been a serious problem in Bangladesh which has led to severe soil degradation. Farmers had no real alternatives in the absence of the organic fertilizers in the market prior to the entrance of compost from Waste Concern in the agricultural input market. Compost produced by Waste Concern has increased per hectare yield by 30–50% by adopters (potato farmers). The Waste Concern business, extending from collecting and processing waste produced in urban areas to selling compost to rural farmers, has created a value chain generating close to 1,000 jobs among the urban poor, especially women. The total value of the compost sold in the local market between 2001 and 2006 was USD 1.10 million. Close to 500,000 people are benefiting from household waste disposal system across the country. Waste Concern has also contributed in reducing greenhouse gas emissions by 62,200 tons of $C0_2e$ between 2001 and 2006 (excluding the CDM project), and saved 13.4 ha of landfill area. The upcoming CDM project is also expected to reduce greenhouse gas emissions by 1 million tons over eight years, produce 50,000 tons of compost per year. At a global scale, this initiative has the potential to reduce transboundary impact of GHG and attract foreign direct investment. Waste Concern has also extended itself in the policy-making arena, steering environmentally appropriate governmental regulations, both existing and new. To date, they have been influential in the development of 27 governmental policies and spearheaded efforts at influencing the government to develop national policies and guidelines in issues in the like of CDM Project Approval Process for Government.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Increasing need for sustainable waste management solutions.
- Strong, strategic partnerships with city municipality, Ministry of Environment and Forests, Dhaka City Corporation, Public Works Department, Community-Based Organizations, Private Fertilizer Companies and development agencies, gaining Waste Concern a.o. free or low-cost access to waste and to land.
- A perceived necessity to replace chemical fertilizers due to their effect in degrading soil and environment.
- Government (ministry of agriculture policy) that support/promoted use of compost for agricultural purposes.

The Waste Concern model has high replication potential and has already been replicated in 27 cities of Bangladesh and 10 cities of developing countries with the support from external support agencies as well as local entrepreneurs. Adopting a labor-intensive, cheap and low technological approach, the business does not require a large capital investment (except for land purchase) or state-of-the-art machinery, which removes one of the major constraints for business start-ups especially in the developing world context. The decentralized composting approach reduces transportation costs and makes use of low cost technologies based on manual labor and ensures waste is well sorted before it is composted. This minimizes many of the problems and difficulties that have led to the failure of large centralized composting plants in the past. There is great potential for the upscaling of this model due to its simplicity. Many decentralized units can be attached to the main business as long as raw material or the market demand does not become limiting factors. However, the decentralized approach to composting of waste work best for secondary cities and small towns where local government can allocate land. Similarly, the large-scale carbon trading model has a high replication potential. The technology adopted is semi-mechanized and offers opportunity to use unskilled and informal labor, indicating its suitability for developing countries.

Summary assessment – SWOT analysis

Figure 161 presents the SWOT analysis for Waste Concern. Composting has become a promising business in Bangladesh. Waste Concern has been particularly successful by using a suitable composting technology in combination with a sound financial management and an appropriate marketing strategy, which enables Waste Concern to produce high quality compost and ensure constant sales throughout the year. This business can hardly meet the demand for compost and processes several hundred tons of city waste daily since 2010 (Waste Concern, 2011). Increasing governmental and international support along with growing demand for normal and enriched compost, spurred by the user awareness building programmes, are seen as key opportunities for replication and up-scaling of the business. Waste Concern will, however, face increasing competition from new market entrants and increased buyer power if it does not explore new key customers or begin to establish its own marketing and distribution channels. Waste Concern is an example of an innovative social entity utilizing a simple business approach to address some of the major waste management and environmental challenges in Dhaka, Bangladesh and its model of organic composting is a clear demonstration of a successful business model that includes the poor, especially women both in the supply and the demand chain.

FIGURE 161. SWOT ANALYSIS FOR WASTE CONCERN

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ Limitless and exclusive supply of municipal solid waste ▪ Low O&M due to adoption of simple technology ▪ Goodwill earned due to environmental stress relief ▪ Good local buy-in due to establishment of brand for quality ▪ Research and development work to strengthen the product ▪ Excellent relationship with partner organizations ▪ Decentralized composting units that do not depend on one another	**WEAKNESSES** ▪ High dependence on few main customers – strong buyer power ▪ Profit structure highly dependent on cheap labor
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Absence of strong competitive organic fertilizer suppliers to the market ▪ Up-scaling potential of CDM project to earn carbon credits and set-up of additional decentralized units ▪ Compost as poultry feed increases the market ▪ Scale of production and transboundary GHG effects can potentially attract Foreign Direct Investment ▪ Scale of impact and steering environmentally-appropriate governmental regulations provides positive market effect	**THREATS** ▪ Increasing competition from other compost businesses ▪ Increasing labor wages ▪ Unstable carbon market

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Josiane Nikiema, IWMI, Ghana

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Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2014/15. As business operations are dynamic data can be subject to change.

Notes

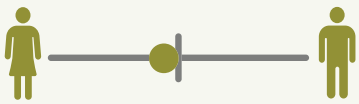
1 Based on 2014 exchange rates: USD 1 = 77.65 taka.
2 For carbon trading purposes, one CER is considered equivalent to one metric ton of CO_2 emissions.

BUSINESS MODEL 12

Large-scale composting for revenue generation

Miriam Otoo and Munir A. Hanjra

A. Key characteristics

Model name	Large-scale composting for revenue generation
Waste stream	Municipal solid waste (MSW), minor percentage of agro-waste
Value-added waste product	Recovered soil nutrients in the form of compost from MSW to address dual challenge of soil nutrient depletion and waste management
Geography	Any urban centre, assuming availability of land for plant construction
Scale of production	Medium to large scale; minimum plant size processes 60–100 tons of MSW per day, with a maximum size of 1,500 tons per day
Supporting cases in this book	Delhi, Ludhiana, Karnataka in India; Dhaka, Bangladesh
Objective of entity	Cost-recovery [ ]; For profit [X]; Social enterprise [X]
Investment cost range	USD 415,000–1.5 million depending on technology used and pay-back period of 2 to 7 years
Organization type	Public, private, public-private partnership, or social enterprise/entity
Socio-economic impact	Environmental benefits from reduced nutrient release into soils and waterbodies from reduced chemical fertilizer use, reduced GHG emissions via reduced production of chemical fertilizers and landfill emissions, reduced human exposure to untreated waste, improved waste management services, cost savings to municipalities from reduced land acreage for landfills and disposal costs
Gender equity	Employment generation for the urban poor, including women. Technology-wise no particular (dis)advantage for any gender 

B. Business value chain

This business model rests on the notion that there is great potential for addressing the dual challenge of waste management and to some extent nutrient soil depletion via the recovery of nutrients from municipal solid waste (MSW) in large urban areas of developing countries. It is important to note that although the former may be the main driving force given the widening service gap between provision of waste management services and municipalities' budgets and infrastructural capacities an equally important driver is the increasing need for environmentally friendly and cost-effective fertilizer alternatives for agricultural producers. Thus, the opportunity of increased cost savings from reduced transportation costs and landfills as well as revenue generation and even profit making explicitly represents opportunities for different entities to engage in compost production from MSW.

A myriad number of constellations based on different scales of production, technologies, business strategies, partnerships, financing, among other factors, exist for this model. This business model

can be initiated by a public, private entity, public-private partnership or a social enterprise to provide sustainable solutions for urban waste management issues and produce value-added products and services that generate significant benefits to several actors in both the sanitation and agricultural value chains. The goal of profit maximization via increased revenue generation drives the business strategies that the entities institute which is hinged on: a) portfolio diversification (multiple-revenue stream approach); and b) strategic partnerships.

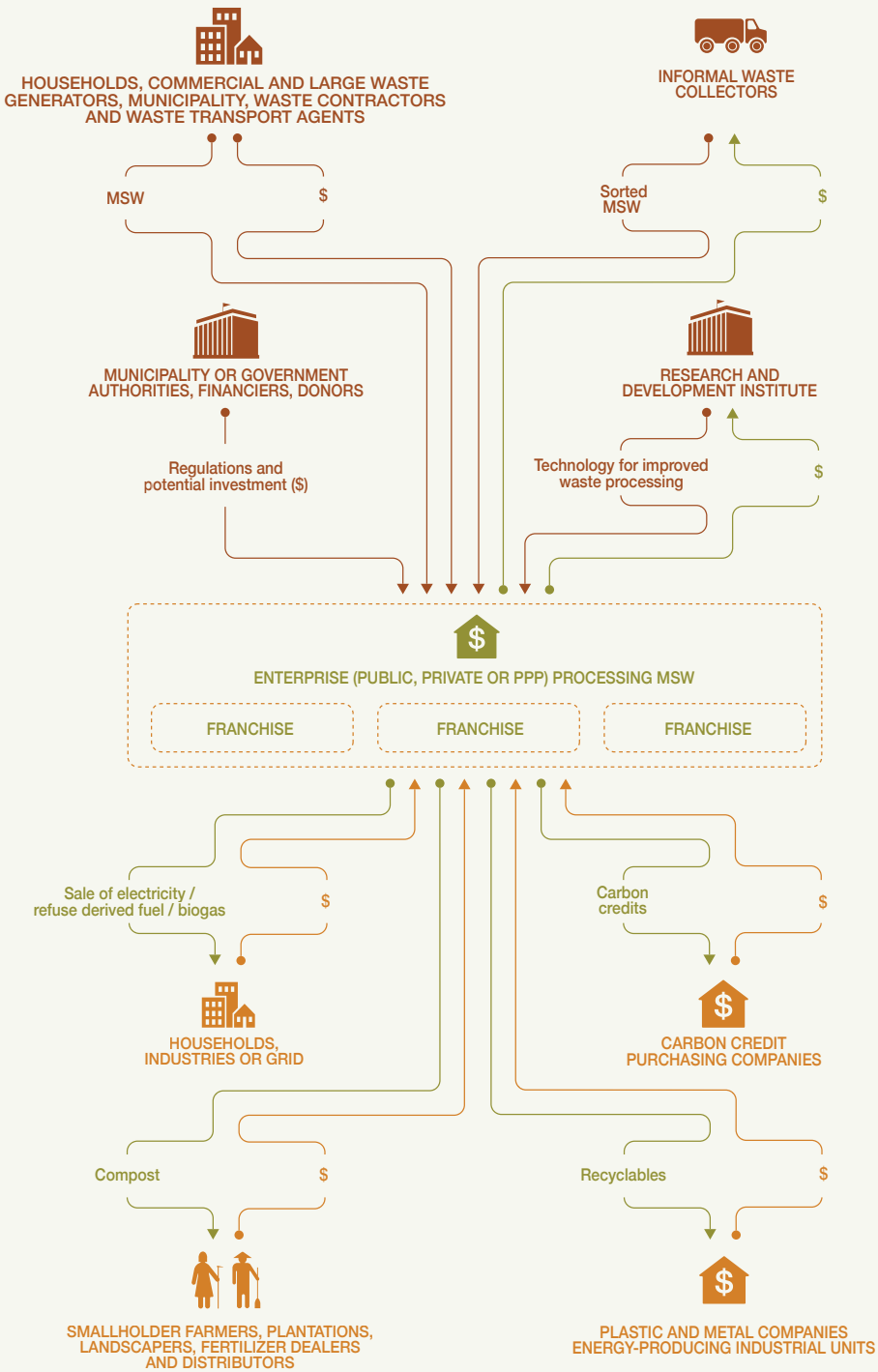
Whilst the core business centres on provision of waste management services and fertilizer alternatives to agricultural producers and generates revenue from: a) waste collection fees charged to the municipality, households or commercial entities; b) sales of organic fertilizer products; c) sales of recyclables; by leveraging its scale, additional revenue streams that can be tapped into are sale of energy (electricity, biogas) and carbon credits. Businesses can also implement a franchise-based approach to increase their revenue streams and capture additional markets. A typical arrangement can include the following: a) the franchiser provides training on technology and management for compost production on a (discounted) fee basis; b) the franchisee sells the compost to the parent company who (can further add-value to the compost) markets and distributes the compost through its established distribution networks or those of its partners. Profits are shared between the franchiser and franchisee depending on agreed percentages outlined in contractual agreements.

Large-scale operations, whether through centralized or decentralized systems, offer the opportunity to capture benefits from economies of scale. Large-scale operations using efficient technologies along the entire compost production process can reduce production costs. This implies that the business can charge lower prices for the compost product and significantly increasing their market share and additionally gain access to new markets, such as the carbon credit market which has scale requirements. Additionally, efficient energy production whether for internal use to reduce production costs or for sale typically occurs at a larger-scale. Especially in the latter case, businesses can only connect to the grid if they are able to supply a certain wattage of electricity.

Strategic partnerships on different levels with the local government, private enterprises and community-based organizations to optimize the allocation of resources and activities, reduce risk associated with high capital investments, establish an assured market for their product, among others, will be imperative for the sustainability of the model, particularly given the multiple elements (activities) of the business. Central to this business model is the enterprise initiating and implementing the model for better waste management and revenue generation, as shown in a generic value chain schematic (Figure 162). Depending on the organizational structure of the model, the ownership, financing and operation of the enterprise transforming MSW to compost can take different forms. For example, management models can include: a) municipally owned – municipally operated; b) municipally owned – privately operated; and c) privately owned – privately operated. This often translates to the mode of financing of the initiative which can be through private equity, government or donor grants or a combination of these (Kaza et al., 2016).

Particularly for PPP initiatives (for example, in the cases of ILFS-Okhla and A2Z Infrastructure Limited-Ludhiana in India), the public entity typically provides the capital investment and outsources the overall management of the plant – to include sales and marketing of the compost products to the private entity. Additionally, from a private entity's perspective, partnership with government authorities in relevant sectors provides easy access to the city's waste streams and the often well-established fertilizer marketing and distribution networks. The former implies that there is no competition from other entities in terms of input supply, ensuring continuous and unlimited access to the waste, whilst the latter increases market access for the compost products. On another front, contracting-out some of the waste collection

FIGURE 162. VALUE CHAIN SCHEMATIC – LARGE-SCALE COMPOSTING FOR REVENUE GENERATION



activities to informal waste collectors brings an inclusive element to a 'for-profit' model. This not only improves the livelihoods of landfill ragpickers by ushering them into mainstream jobs but it can allow the business to efficiently cover slum areas where poor road infrastructure make them less accessible.

C. Business model

The business model is hinged on a multiple-revenue stream approach which results in three value propositions: a) provision of sustainable and affordable waste management services to communities and businesses; b) increased supply of environmentally-friendly fertilizer alternatives to agricultural producers at affordable prices; and c) provision of recyclables to energy-producing industrial units at competitive market prices. The business model described here presumes the operation for a standalone private enterprise (Figure 163).

The provision of waste management services (i.e. waste collection) from households, commercial entities, institutions at a fee, can generate significant income. The business will however require a sound partnership agreement with the local authorities or municipality to ensure exclusive rights to the city's waste. The business additionally produces organic fertilizer products from MSW and minimally agro-waste. The main customer segments are agricultural producers who can be reached via direct sales or partner dealer networks. Given the large scale of operation, a secure market is needed for the compost. In that regard, the business has to consider innovative marketing and distribution strategies as well as product development. Strategies to be considered include: a) **partnerships** with government, agriculture departments and agro-industries, to take advantage the often well-established fertilizer distribution networks; b) **market segmentation** – different prices are charged to different customer segments to capture a larger share of the consumer surplus; c) **production innovation –** increase the accessibility and usability of compost via pelletization (as the bulky nature of compost often acts as a barrier to the transportation of the product to markets, increasing the distribution costs, which are borne by the end-users) and nutrient fortification to boost compost fertilizer value. For the latter strategy, partnership with a research institute is crucial to ensure continued product and process innovation.

This business model can also derive additional revenue from recovered non-degradable materials including high density plastics and metals that could be sold directly to the plastic and metal companies and the remaining solid materials to energy producing industrial firms for refused derived fuel (RDF). This business model adds two new stakeholders – inorganic material clients such as plastic manufacturing and energy producing commercial units using RDF, and informal waste collectors, adding value through collection and sorting of these materials, while also generating employment for these informal sectors workers including women. For large-scale operations, waste segregation into biodegradable and non-biodegradable portions is mainly a mechanized process but some level of sorting can be done by rag pickers. This model does not only improve the livelihoods of rag pickers (via assured and increased earning) but it increases coverage of slum areas where poor road infrastructure makes them inaccessible for mechanized operations. The demand for inorganic materials including refused derived fuel and plastics/metals is growing and collection costs could easily be covered through household fees. Wastes of particle size greater than 50mm can be sorted, shredded, packaged and sold partly to electricity units as well as cement, tile manufacturing and brick units. A portion of the remaining RDF material can be sold and the remaining quantities burnt to generate electricity for the business' internal use.

Alternate scenarios

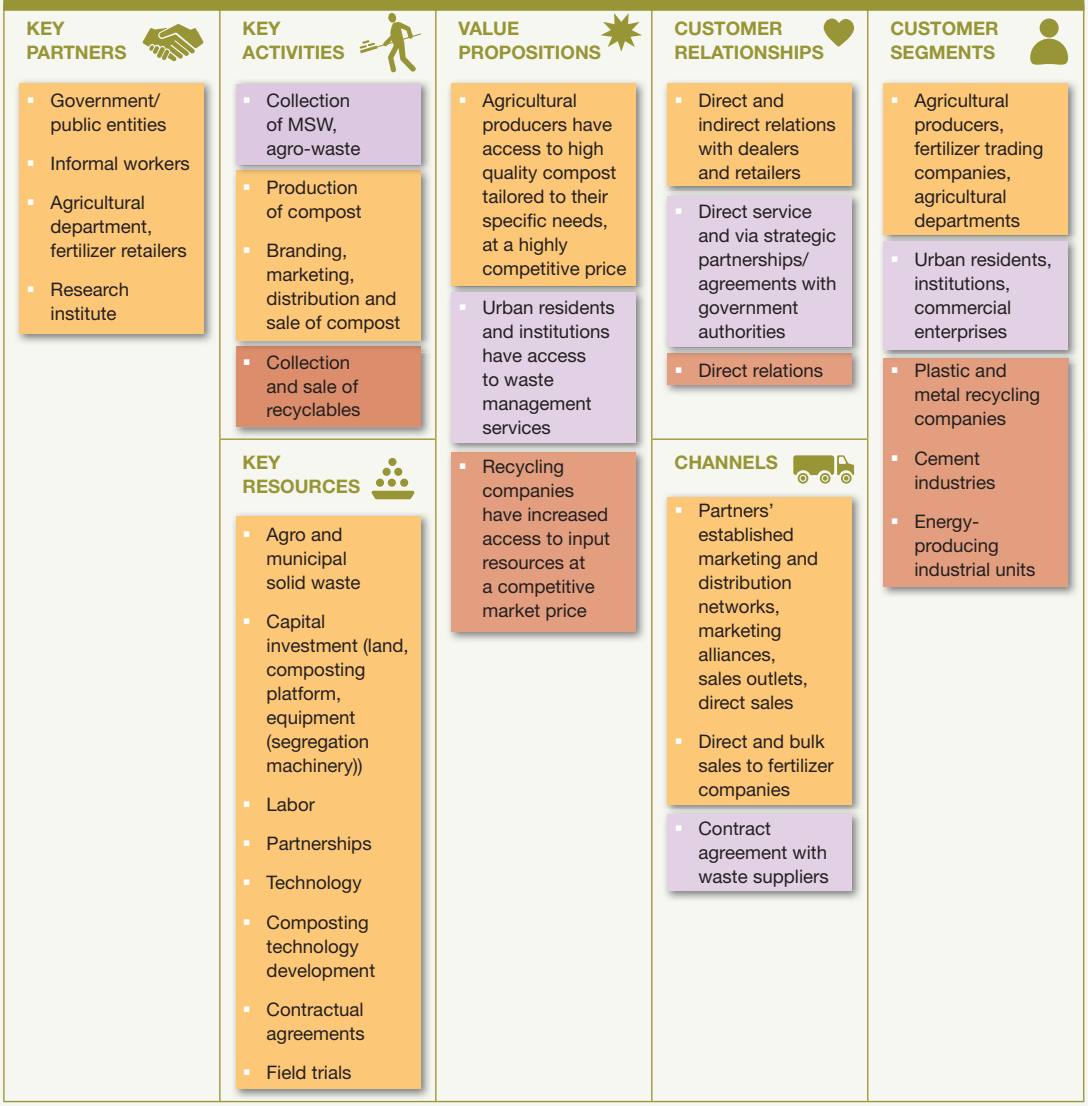
The generic business model described above is to produce compost from MSW for agricultural purposes and provide waste management services. The business can be modelled along three

different scenarios to include: a) a franchise system; b) energy (biogas and/or electricity) generation for internal use or sale to the grid; c) large-scale operations for carbon credits under the CDM.

Scenario I: Commercial establishment for composting through consultancy services and franchising royalties

This business model (Figure 164 on page 440) builds on the generic model described above. The business sets up a franchising system to its compost production component of the business to further increase its market access (in terms of provision of waste management services to communities and organic fertilizers to agricultural producers) and revenue. The multi-revenue approach adopted by the business will support its transition from a cost-recovery model to one of profit generation. In addition to

FIGURE 163. BUSINESS MODEL CANVAS – LARGE-SCALE COMPOSTING FOR REVENUE GENERATION



COST STRUCTURE

- Capital investment costs (land, infrastructure, equipment)
- Operation and maintenance costs (labor, R&D, marketing and distribution costs, administrative costs)
- Financing costs (interest on borrowed funds)
- Payment of shared revenues (if any)

REVENUE STREAMS

- Sale of compost products
- Service fees from households, institutions, commercial establishments
- Sale of recyclables
- Government assistance (if any) for compost programs under sustainable agriculture programs

SOCIAL & ENVIRONMENTAL COSTS

- Possible health risk to workers if appropriate protective gear is not used during production processes, especially when handling the raw waste
- Possible water and soil contamination if leachate from the compost production is not captured and treated appropriately

SOCIAL & ENVIRONMENTAL BENEFITS

- Reduced existing waste management costs
- Reduced human exposure to untreated waste
- Reduction of greenhouse gas emissions
- Reduced acreage for landfills
- Improved environmental health
- Enhanced soil fertility and productivity from increased use of organic fertilizers for agricultural production
- Capacity development of local farmers
- Significant job creation for the poor without any gender discrimination

earning revenue from waste management service fees, sale of organic compost and fertilizer products and sale of inorganic recyclables, they can earn franchising royalties from their franchise network operating across different locations that provide waste management products and services. Depending on if the business is a public, private, PPP or social entity, the incremental revenue (if representative of a surplus) can be reinvested in technology innovation and new marketing strategies to further improve production efficiencies and dependence on partners' distribution networks, respectively. The franchise system also creates a greater opportunity for the parent business to enter into a CDM program. This is because the parent business may only be able to meet the scale of operation requirements for carbon credits sale upon inclusion of the franchisees' operations. The incorporation of a franchising system additionally builds inclusivity into the original business model as smaller-scale enterprises (such as CBOs) gain access into the waste management sector and generate jobs/income for individuals that would otherwise be unemployed. The parent business can further earn revenue via consultancy fees charged for the design and commissioning of waste management projects for townships and commercial clients, and the training of agricultural graduates and professionals in the field of waste management and compost production.

Scenario II: Energy generation and carbon credit sales

With the inherent large scale of operations (or derived from aggregate scale of franchises, the parent enterprise can efficiently produce energy for its own onsite use or enter into a partnership with the state electricity board and sell any surplus energy to the national grid. The business' ability to tap into the energy market is highly dependent on its scale given the minimum wattage requirements for electricity sale to the national grid. Cost-savings from use of internally-produced energy imply decreased production costs, and along with the sale of electricity increased revenue generation. This model can maximize resource recovery from municipal solid waste, diversify its portfolio beyond compost production, mitigating risk associated with seasonal compost demand and marketing, and

FIGURE 164. BUSINESS MODEL CANVAS – LARGE-SCALE COMPOSTING FOR REVENUE GENERATION WITH FRANCHISING SYSTEM

KEY PARTNERS

- Government/ public entities
- Informal workers
- Agricultural department, fertilizer retailers
- Research institute

KEY ACTIVITIES

- Collection of MSW, agro-waste
- Production of compost
- Branding, marketing, distribution and sale of compost
- Collection and sale of recyclables
- Provision of consultancy and design services for turn-key waste management projects and franchisees operations
- Marketing and distribution support to franchisees facilities

KEY RESOURCES

- Agro and municipal solid waste,
- Capital investment (land, composting platform, equipment)
- Labor
- Partnerships
- Technology
- Composting technology development
- Field trials
- Contractual agreements (including franchising contracts)

VALUE PROPOSITIONS

- Agricultural producers have access to high quality compost tailored to their specific needs, at a highly competitive price
- Urban residents and institutions have access to waste management services
- Recycling companies have increased access to input resources at a competitive market price
- Increased creation of business operations for communities via franchises

CUSTOMER RELATIONSHIPS

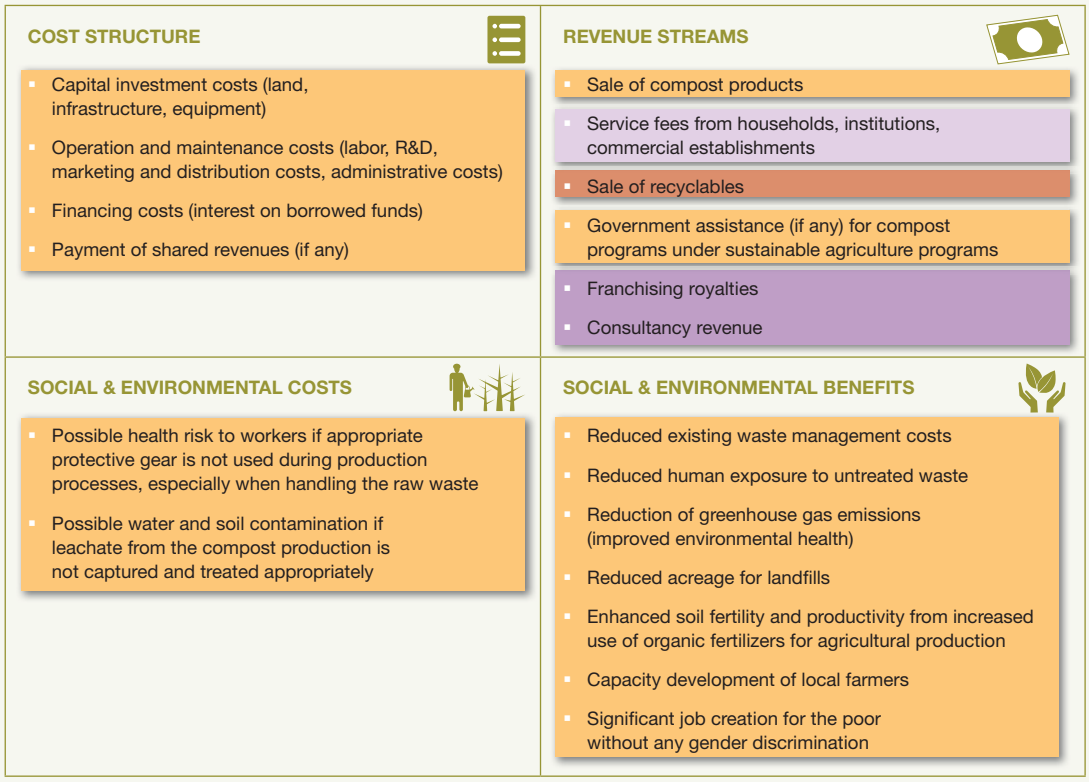
- Direct and indirect relations with dealers and retailers
- Direct service and via strategic partnerships/ agreements with government authorities
- Direct relations
- Formal franchisee agreements

CHANNELS

- Partners' established marketing and distribution networks, sales outlets, direct sales
- Direct and bulk sales to fertilizer companies
- Contract agreement with waste suppliers
- Direct sale
- Open bidding, call for tenders

CUSTOMER SEGMENTS

- Agricultural producers, fertilizer trading companies, agricultural departments
- Urban residents, institutions, commercial enterprises
- Plastic and metal recycling companies
- Cement industries
- Energy-producing industrial units
- Clients of franchise network



allow entry into the energy market. There is a great potential to improve the financial viability of the model from energy generation as there is generally a significant and growing demand for electricity in developing countries. Additionally, there are increasing opportunities for waste-to-energy entities to fill this gap based on the anticipated rapid rural electrification program; foreseeable increasing trend in electricity prices; structural and legal feasibility for private sector involvement (structural unbundling of the power sector, vertically integrated monopoly and privatization of the generation and distribution); a lesser vertically integrated market; and supportive renewable energy policies among others. It is noted however that particularly in developing countries, electricity producers are currently price takers and restricted to the price ceiling set by the state-owned transmission entity (limited negotiation ability – monopolistic market). Thus, the level of market concentration and market prices will determine whether investments in plant upgrades and equipment for energy production is worthwhile. The opportunity for waste-generated electricity can only materialize if the price offered in power purchase agreements (PPA) can substantially cover production costs and generate a net profit. The generation of energy, in addition to providing cost savings from internal use and generating sales revenues, can be accounted for carbon credit sales.

The business entity can also be registered as a CDM (Clean Development Mechanism) project to earn additional revenue from carbon credit sales to UNFCCC Annex I defined countries[1]. The composting of municipal solid waste offers opportunities for earning carbon credits through two main pathways: a) avoided GHG emissions from landfills; and b) reduced GHG emissions from reduced chemical fertilizer production and use. Carbon credits earned through avoided emissions over the base-case scenario can be sold in the global credit market to institutional and private investors (Figure 165). Carbon credits provide an additional value proposition that in most cases can help composting businesses on

FIGURE 165. BUSINESS MODEL CANVAS – LARGE-SCALE COMPOSTING WITH ENERGY GENERATION AND CARBON CREDITS SALE

KEY PARTNERS

- Government/ public entities
- Informal workers
- Agricultural department, fertilizer retailers
- Research institute
- International development agencies (for CDM process)

KEY ACTIVITIES

- Production of compost
- Branding, marketing, distribution and sale of compost
- Research and development
- Collection of MSW, agro-waste
- Collection and sale of recyclables
- Provision of consultancy and design services for turn-key waste management projects and franchisees operations
- Marketing and distribution support to franchisees facilities
- Production of biogas (bio-methanation) for internal use
- Production and sale of electricity
- Managing CDM processes to obtain emission reduction credits

KEY RESOURCES

- Agro and municipal solid waste,
- Capital investment (land, composting platform, equipment)
- Labor
- Partnerships
- Technology
- Composting technology development
- Field trials
- Contractual agreements (including franchising contracts)
- Positive (image) reporting by media on Green Economy

VALUE PROPOSITIONS

- Agricultural producers have access to high quality compost tailored to their specific needs, at a highly competitive price
- Urban residents and institutions have access to waste management services
- Recycling companies have increased access to input resources at a competitive market price
- Increased creation of business operations for communities via franchises
- Reduction in energy demand and expenditure from internal energy generation and use
- Improved energy availability to communities and businesses
- Tradable certified emission reduction to meet carbon emission commitments

CUSTOMER RELATIONSHIPS

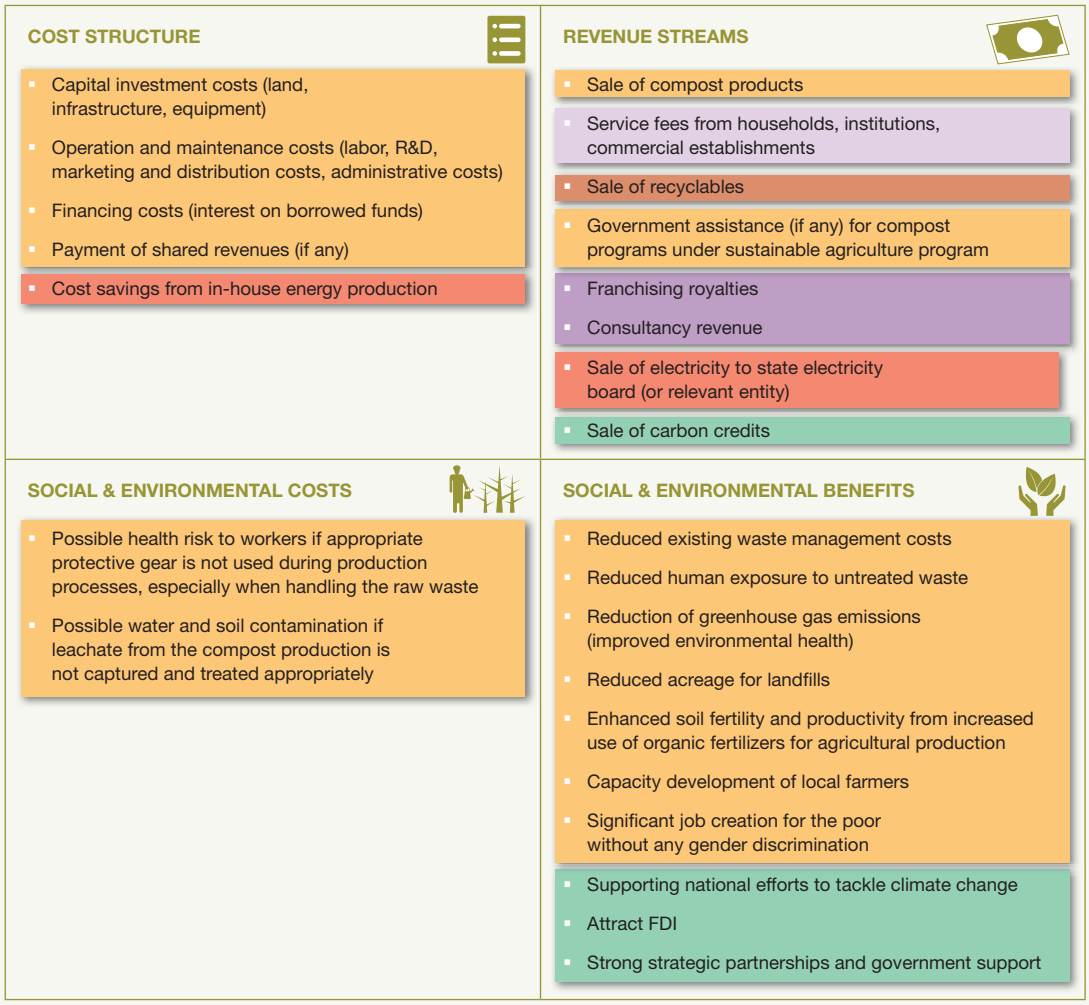
- Direct and indirect relations with dealers and retailers
- Direct service and via strategic partnerships/ agreements with government authorities
- Direct relations
- Formal franchisee agreements
- Formal contractual agreement with government
- Registered as CDM at UNFCCC

CHANNELS

- Partners' established marketing and distribution networks, marketing alliances, sales outlets, direct sales
- Direct and bulk sales to fertilizer companies
- Contract agreement with waste suppliers
- Direct sale
- Open bidding, call for tenders
- Contract agreement with state electricity board
- CDM certificate trading on international market

CUSTOMER SEGMENTS

- Agricultural producers, fertilizer trading companies, agricultural departments
- Urban residents, institutions, commercial enterprises
- Plastic and metal recycling companies
- Cement industries
- Energy-producing industrial units
- Clients of franchise network
- State electricity board
- Investors from UNFCCC Annex I countries



a trajectory for profitability. However, the application process for a CDM project can be lengthy and complicated, involving certification, verification and accreditation to ensure compliance with various international standards, and often requiring additional investments for plant upgrade or retrofits. This thus requires support from international development agencies, government entities, and other private sector entities (consultancy support for formulation and submission of the application). In view of associated risks, the net returns on investment in the CDM project have to be carefully considered.

Scale plays an important role in this model given the related requirements for carbon credit sales. Additionally, waste-to-energy generation, which can contribute to improving the eligibility for a CDM project, requires a certain scale of operation for full efficiency. See Figure 165 for a diagrammatic representation of the business model.

Potential risks and mitigation

The business model presented here was designed and optimized based on the analysis of different case studies (see previous sections). In designing this optimized business model, risks related to safety, local acceptance by the community, and business attractiveness for investors were assessed.

Market risks: In developing countries, the composting business has the potential of being a burgeoning industry. However, there are oftentimes market entry barriers that may limit business development. The organic fertilizer market is typically less commercialized and the related market structure and business dynamics can be informal, while the inorganic fertilizer market, on the other hand, is more formal and commercialized. A market condition that would potentially affect the sustainability of compost businesses is the market power held by chemical fertilizer producers. This is because the fertilizer market can be traditionally highly concentrated – with few chemical fertilizers companies having the largest share of the market (characteristic of a strong oligopolistic market) – although a limited established distribution network represents an opportunity that organic fertilizer producers can capture.

Additionally, existing policies (e.g. price subsidies) supportive of chemical fertilizers distort market prices making compost comparatively more expensive; and making it difficult for compost producers to enter the market. New organic fertilizer businesses will need at the start-up a highly unique and differentiated product, and innovative marketing strategies to mitigate these competition effects. Furthermore, high seasonality in demand for compost may increase investment cost for storage facilities which may also imply increased operational costs. Risks related to the waste input market are relatively low for this model as it is assumed that depending on the type of entity operating the composting business (i.e. public, private, PPP or social entity), they have exclusive ownership or access (via partnership agreement) to the relevant waste streams. Another significant risk that the business needs to consider is the price volatility in the carbon market. If a business is highly dependent on carbon credit sales for its viability, then it puts its sustainability at an increased risk. As mentioned above, particularly in developing countries, electricity producers are price takers and restricted to the price ceiling set by state-owned transmission entities. Limited negotiation ability in a monopolistic/oligopolistic market puts the business' viability at risk if highly dependent on energy revenue sales.

Competition risks: Key market competition (fertilizer market) as noted above arises from policy instruments that make substitute products more affordable to farmers than compost. Additionally, competition for cheap labor will imply increasing labor wages which may imply increased operational costs for the business if the technologies/production processes are more labor-intensive than mechanized. A profit structure that is highly dependent on cheap labor exposes a business' viability to significant uncertainties.

Technology performance risks: The composting technology typically used (windrow composting) is a relatively mature and simple technology. For large-scale operations, it can be highly mechanized which implies increased investments in advanced technologies and labor costs for highly skilled labor. Additionally, given its high energy requirements, any shortage or infrequency in energy supply can significantly affect operations and in turn business viability. The option of energy generation for internal use can address this challenge. Although, it is worth noting that investments in the required technologies can be costly. Centralized operations may imply high transportation costs, however the adoption of a more decentralized operational system (e.g. via franchises) can reduce the resulting operational costs.

Political and regulatory risks: Policies and regulations related to waste-based compost sectors differ by country. The oftentimes stronger political support for chemical fertilizer use (slow phasing-out of fertilizer subsidies) and lack of specific government guidelines for the certification of compost and internationally accredited third-party certification entities can represent a significant risk to the sustainability of the business model. Furthermore, for the additional value proposition of energy generation, certain limiting factors to business development and sustainability have to be taken into consideration, particularly for developing countries: a) continued interest and large hydro-power potential; b) significant interest in small hydro-power projects; and c) waste-to-energy projects currently viewed as high-risk ventures by financial investors. While producer prices can be increased, additional

market failures inherent in the energy sector can only be rectified with the institution of sound policies. Additionally, even with fairly easy entry into the energy market, transaction cost associated with long negotiation processes can be representative of a barrier to market entry. Additionally, high capital requirements and difficulty in accessing funds can be a disincentive for new businesses. By nature of the industry, the lead time for projects can be long and the cost of loan appraisal huge, especially for small projects. Lenders often tend to be concerned about government's interference in the tariff review process and which can increase the tariff risk (regulatory risk) and viewed as reducing businesses' repayment ability.

Social equity related risks: Similar to Business Model 11, this model does not result in any clear social inequity risks. On the other hand, with an extensive reach across the MSW value chain, it has the potential to generate thousands of jobs among the urban poor, particularly for women who are traditionally known to engage in waste segregation. On another front, contracting-out some of the waste collection activities to informal waste collectors brings an inclusive element to a 'for-profit' model. This not only improves the livelihoods of landfill ragpickers by ushering them into mainstream jobs but it can allow the business to efficiently cover slum areas where poor road infrastructure make them less accessible.

Safety, environmental and health risks: On one hand, the simplicity and labor-intensive technology of large scale MSW composting can offer many job opportunities for unskilled workers. On the other hand, MSW is usually contaminated by fecal matter ("flying toilets") and thus poses a higher risk of pathogenic exposure, aside physical hazards (glass, metal) for workers, as well as possible chemical contaminants which might enter the compost and food chain. The provision and use of protective gear for all production operations should thus be mandatory. From the consumer perspective, microbial testing should be a routine measure for quality assurance of MSW compost products. Additionally, farmers must be trained on the appropriate application methods for the waste-based fertilizer products. Recommendations of national agriculture agencies must also be implemented in tandem, in association with agricultural extension agents. To address safety and health risks to workers, standard protection measures are required as shown in Table 41.

TABLE 41. POTENTIAL HEALTH AND ENVIRONMENTAL RISK AND SUGGESTED MITIGATION MEASURES FOR BUSINESS MODEL 12

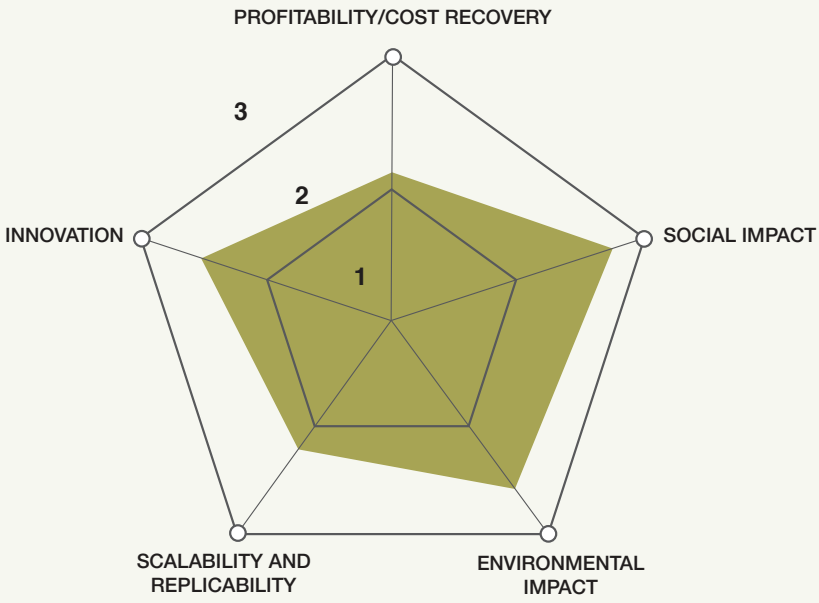
RISK GROUP	EXPOSURE					REMARKS
	DIRECT CONTACT	AIR/ DUST	INSECTS	WATER/ SOIL	FOOD	
Worker						Risk of sharp objects in MSW and fecal contamination Potential risk of dust, noise, and chemical compost contaminants
Farmer/user						
Community						
Consumer						
Mitigation Measures						

Key: NOT APPLICABLE; LOW RISK; MEDIUM RISK; HIGH RISK

C. Business performance

This model ranks high on profitability and this is attributable to the multiple-revenue stream approach it implements (Figure 166). By diversifying its portfolio, the business is able to mitigate risks, for example, associated with seasonal compost demand, with a combination of revenue generation from sale of energy, carbon credits, recyclables, waste collection service fees and franchise royalties. This model is ranked high on social impacts due to benefits to the wider society in terms of providing sustainable waste management services and nutrient recovery as organic fertilizer for reuse to support more productive and sustainable farming, also generating new jobs for people. The model ranks high on environmental impacts due to its role in protecting public health and the environment by significantly reducing GHG emissions from landfilled waste, waste disposal costs and (large-scale operations) and contributing to soil health while restoring degraded and exhausted soils. The model also ranks high on innovation in terms of adaptation of technology to local conditions and innovative partnerships and pricing strategy, but lower on scalability and replicability due to large capital investment requirements.

FIGURE 166. RANKING RESULTS FOR THE BUSINESS MODEL ON LARGE SCALE COMPOSTING FOR REVENUE GENERATION



References and further readings

Kaza, S., Yao, L., Stowell, A. 2016. Sustainable financing and policy: models for municipal composting. Urban development series Knowledge Papers 24. Washington, D.C.: World Bank Group.

Note

1 Industrialized or transitional economies as listed in Annex I of the United Nations Framework Convention on Climate Change (UNFCCC).

10. BUSINESS MODELS ON NUTRIENT RECOVERY FROM OWN AGRO-INDUSTRIAL WASTE

Introduction

With increasing scales of production, agro-industrial businesses (tea plantations, livestock producers, agro-processing businesses) are increasingly looking for sustainable treatment and disposal alternatives for the huge amounts of agro-waste (vegetative and livestock) that they produce. Livestock production has shown an accelerated growth in the past two decades, increasing by 62% in comparison with the 1990s, for example, in Latin America. As a result of this progressive increase in the agricultural sector, 84% of the total methane emissions were accounted to livestock production in 2002 (SEMARNAT, 2008). Additionally, livestock operations (swine, dairy cows, etc.) can generate serious environmental consequences such as greenhouse gas (GHG) emissions, odor and water/land contamination, all a result from storage and disposal of animal waste. Confined Animal Feeding Operations (CAFOs) use Animal Waste Management System (AWMS) options to store animal residues. These systems emit both methane (CH_4) and nitrous oxide (N_2O) resulting from aerobic and anaerobic decomposition processes (UNFCCC, 2012). Agricultural producers and food processors similarly face the challenge of sustainably treating and disposing off the waste generated. To ensure business sustainability (largely compliance with legislative mandates), these entities are increasingly implementing an additional arm to their main business to convert their waste into an organic fertilizer, especially given that the implicit cost of non-compliance can be significant, in view of their large scale operations and the resulting potential loss of up to several millions of dollars in annual revenue.

This business model – **onsite nutrient recovery** – is therefore hinged on the concept of the processing of a business' 'own' waste to organic fertilizer to reduce waste disposal costs and, generate revenue while ensuring the sustainability of the larger business entity as a whole. The model generates the double value proposition of:

- Provision of sustainable and environmentally friendly waste management options for agro-industrial entities (livestock producers, agricultural producers and agro-processors);
- Provision of affordable and high quality organic fertilizer for agricultural production.

This business model works for several reasons: a) it is built around harnessing economic value from agro-waste whilst ensuring business sustainability at a higher level and providing a highly-demanded, affordable and nutrient-rich organic fertilizer to farmers; b) the parent company typically provides the capital investment for the set-up of compost operations which mitigates capital investment risk; c) assured supply of key production input (livestock waste); and d) increasing global demand for organic foods and invariably organic farmers. The business also takes advantage of economies of scale and focuses on low cost, yet efficient technologies for compost production and improved waste management. By using value-addition technologies, high quality compost tailored to specific clients and agricultural purposes can be produced, and along with third party product certification can help garner significant market demand. Depending on the waste stream (e.g. livestock waste) and technology used, some health risks may ensue particularly to actors along the compost production chain. The exclusive focus and dependence on the launching customer (parent entity) can induce the business to lose touch with the larger 'agricultural' market and limit opportunities for business growth.

Several variants of this business model are possible as explained in the model description and case examples provided in this chapter. Our examples are not exhaustive and better cases could have been inadvertently omitted due to information and time constraints, but cover a wide range of easily accessible cases at scales in selected settings in India, Kenya and Mexico. Our case examples show that this business model can be technically feasible and financially viable.

References and further readings

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CASE

Agricultural waste to high quality compost (DuduTech, Kenya)

Miriam Otoo, Nancy Karanja, Jack Odero and Lesley Hope

Supporting case for Business Model 13	
Location:	Naivasha, Kenya
Waste input type:	Vegetative waste, livestock waste
Value offer:	Vermicompost
Organization type:	Private
Status of organization:	Operational since 2005
Scale of businesses:	Processes 125 tons of waste per month
Major partners:	Finlays Kenya Limited, Local livestock farmers

Executive summary

DuduTech is an autonomous division within the parent company Finlays Kenya Limited, producing and selling biological control organisms for Integrated Pest Management (IPM), together with the production and sales of vermicompost. Finlays – a wholly owned subsidiary of the Swire Group – is engaged in the production and processing of tea and horticultural products. With increasing scales of production, Finlays needed to identify sustainable treatment and disposal alternatives for their vegetative waste and dependence on synthetic pesticides – thus their motivation for the establishment of DuduTech. DuduTech's business model – onsite nutrient recovery – is hinged on the concept of the processing of a business' 'own' waste to organic fertilizer to reduce waste disposal costs, generate revenue via portfolio diversification and mitigate risk associated with fluctuations in compost while ensuring the sustainability of the larger business entity on a whole. Key success drivers for DuduTech's model are: a) portfolio diversification through the sale of biological control organisms and vermicompost; and b) market segmentation – sale of compost at USD 0.4/ton to Finlays (mother company) and USD 0.74/ton to other clients. Strategic partnerships have also contributed to DuduTech's sustainability. Animal manure is purchased on a contractual basis from local livestock producers for a fee as a corporate social responsibility gesture. Windrow and vermicomposting technology is used to process the livestock waste and vegetative waste from Finlay into a vermicompost – Vermitech. The use of a simple and labor-intensive technology not only gives DuduTech a competitive advantage for production, but also generates employment particularly for low-income persons who would otherwise be unemployed. The purchase of feedstock from local livestock farmers represents an added income-generation stream and implicit improvement of their livelihoods. DuduTech's activities have contributed to a reduction in water and soil pollution from reduced nitrate release attributed to chemical fertilizer use. DuduTech's long-term goals remain: a) to achieve good practices in sustainable and safe agriculture; b) to improve and sustain soil health; c) to up-scale its activities via production mechanization to satisfactorily serve

other customer segments; and d) to develop versatile products for soil health improvement to carve its niche in the fertilizer market.

KEY PERFORMANCE INDICATORS (AS OF 2015)						
Land use:	0.5 ha					
Capital investment:	USD 46,460					
Labor:	11 people (2 skilled, 9 unskilled)					
O&M costs:	USD 103 per ton of vermicompost					
Output:	40 tons of vermicompost per month					
Potential social and/or enviornmental impact:	Creation of 11 jobs, reduction of water and land pollution, reduction of CO_2 emissions					
Financial viability indicators:	Payback period:	5 years	Post-tax IRR:	N.A.	Gross margin:	N.A.

Context and background

DuduTech is located in the outskirts of Naivasha, a market town in rift valley province of Kenya, lying North West of Nairobi. Naivasha is on the shore of Lake Naivasha and along the Nairobi-Nakuru highway and Uganda Railway. It is part of the Nakuru district and has an urban population of 14,563 (1999 census). The main industry is agriculture, especially floriculture. DuduTech was established in 2001 as an autonomous division within the parent company Finlays Limited which was founded in 1750. Finlays as a wholly owned subsidiary of the Swire Group, has extensive tea and horticultural interests in Kenya, South Africa, Sri Lanka and China. The motivation for the establishment of DuduTech was Finlays' vision for sustainable and safe agriculture. Apart from environmental conservation through reduction in the amount of nitrates released into the soil from the use of chemical fertilizers, the availability of safe vermicompost has enabled Finlays to produce certified organic products and obtain Fair Trade Certification. This certification brands products as those meeting internationally-set environmental and labor standards and thus receives higher market prices – from which Finlays has substantially benefited.

Market environment

Finlays – a major tea and horticultural production and processing business entity – generates approximately 125 tons of vegetative waste weekly. With plans for increasing their scale of production, Finlay faces a significant challenge with the management of their waste, which was disposed of in open spaces within their farms. The conversion of vegetative waste to compost represents a sustainable option for Finlays to reduce its current and future land requirements for waste disposal. Furthermore, the continuous use of chemical fertilizers has had a negative effect on soils and water bodies from the release high quantities of nitrates. This in addition to the increasing international demand for organic agricultural products has catalysed the promotion of organic farming and the demand for related agricultural inputs. Finlays' desire to tap into the international market segment requires their use of agricultural inputs that meet organic farming standards. It is in this regard that the development of DuduTech remains crucial for the sustainability of Finlays but also the growing agricultural sector in Kenya.

Macro-economic environment

In the early 1990s, fertilizer markets were liberalized, government price controls and import licensing quotas were eliminated, and fertilizer donations by external donor agencies were phased out. Fertilizer use then almost doubled over the 15-year period from 1992 to 2007, with much of the increase attributable to smallholder farmers. The liberalization of the foreign exchange regime in 1992, resulted

in the convergence of what were then the official and the parallel market exchange rates, and effectively removed implicit taxation on fertilizers amongst other imports. While availability of fertilizers has been enhanced, these measures did not have the desired impact of lowering retail prices. This suggests that although businesses such as DuduTech may face fierce competition, organic fertilizer prices remain comparatively more cost-effective than those of chemical fertilizer. Additionally, increasing consumer preferences for organic foods and related local and global prices are representative of factors supportive for the development and sustenance of businesses such as DuduTech – given the related demand by farmers for organic agricultural inputs.

Business model

DuduTech's business is to process the waste of its parent company – Finlays Kenya Limited – into a valuable resource, vermicompost, and also produce and sell biological control organisms for agricultural purposes. Key success factors of DuduTech's business model have been: a) partnership with parent company to mitigate capital start-up risk and ensure continuous supply of vegetative waste; b) diversified portfolio through the sale of biological control organisms and vermicompost; c) segmented markets for its compost product. Vermitech, the brand name for the compost product is sold directly to Finlays and other local agricultural producers. Finlays' purchases represent 80% of all sales, with the remaining 20% by local farmers. The large purchase of the parent company represents an assured product demand and mitigates any risk associated with fluctuations in demand. Essential to DuduTech's business model is the market segmentation of its customer base. It sells compost at USD 0.4/ton to Finlays and USD 0.74/ton to other clients. It is thus able to recover the majority of its cost from the price differential. Additionally, DuduTech has invested a lot in developing high quality products, which has given it a competitive advantage in the fertilizer market, and has also enabled Finlays to produce certified organic products and obtain Fair Trade Certification. This certification brands products as those meeting internationally-set environmental and labor standards and thus receives higher market prices – from which Finlays has substantially benefited. For the production of the vermicompost, DuduTech sources its waste inputs – vegetative waste and animal manure – from Finlays and local livestock producers, respectively. These strategic partnerships have contributed to DuduTech's sustainability as they assure a consistent supply of inputs. Windrow and a vermicomposting technology is used to process the livestock and vegetative waste into a vermicompost. The use of a labor-intensive technology not only gives DuduTech a competitive advantage for production, but also generates employment particularly for low-income persons who would otherwise be unemployed. Although making use of an abundant input, labor, increasing wages have motivated DuduTech to explore the use of a more mechanized technology for labor-intensive activities such as heaping, turning and bagging, especially in light of foreseen production expansion. See Figure 167 for diagrammatic representation of the business model for Dudutech.

Value chain and position

Figure 168 provides an overview of DuduTech's value chain. The business sources its key inputs: vegetative waste and animal manure from Finlays and local livestock farmers (as part of its corporate social responsibility project), respectively. Access to and supply of vegetative waste is assured as Finlays currently produces more waste than DuduTech can actually process. On the other hand, however, DuduTech faces potential competition for animal manure given its demand for agricultural purposes. To mitigate this production risk, DuduTech plans to source this waste from larger scale livestock producers on a long-term contractual basis. DuduTech sells its products – compost and biological control organisms – to Finlays and other local farmers. The production capacity of DuduTech is approximately 10 tons per week of which about 80% is sold to Finlays. Vermicomposting gives Vermitech an edge over other compost products and chemical fertilizers in terms of its water retention capacity. Field trials have established a 30% reduction in irrigation when Vermitech was used in

FIGURE 167. DUDUTECH'S BUSINESS MODEL CANVAS

KEY PARTNERS

- Finlay company (parent company)
- Small scale local livestock farmers

KEY ACTIVITIES

- Vermicomposting of plant and animal manure
- Quality control of compost products
- Sales of vermicompost
- Collection of plant waste from tea and flower plantations of mother company
- Collection of animal manure from small farms (free of cost)
- Produce and sell biological control organisms

KEY RESOURCES

- Equipment
- Labor (skilled and unskilled)
- Capital
- Land
- Vegetative and animal waste
- Partnership
- Branding

VALUE PROPOSITIONS

- Provision of sustainable options for waste generated from production and processing of tea and flowers, providing space of productive areas.
- Offer of a nutrient-rich, certification-grade quality vermicompost suitable for the production of 'Fair Trade Certified' agricultural products
- Provision of biological control organisms for the control of pests and diseases

CUSTOMER RELATIONSHIPS

- Parent–daughter company
- Personal at direct sales

CHANNELS

- Direct channel with parent company
- Direct sales

CUSTOMER SEGMENTS

- Finlays Kenya Limited
- Small- and large-scale farmers; Finlays Limited

COST STRUCTURE

- Capital investment (equipment, land, infrastructure)
- Operation and maintenance costs
- Laboratory costs

REVENUE STREAMS

- Sale of vermicompost to segmented markets: 80% of sales to parent company and 20% to large and small farms
- Sale of biological control organisms

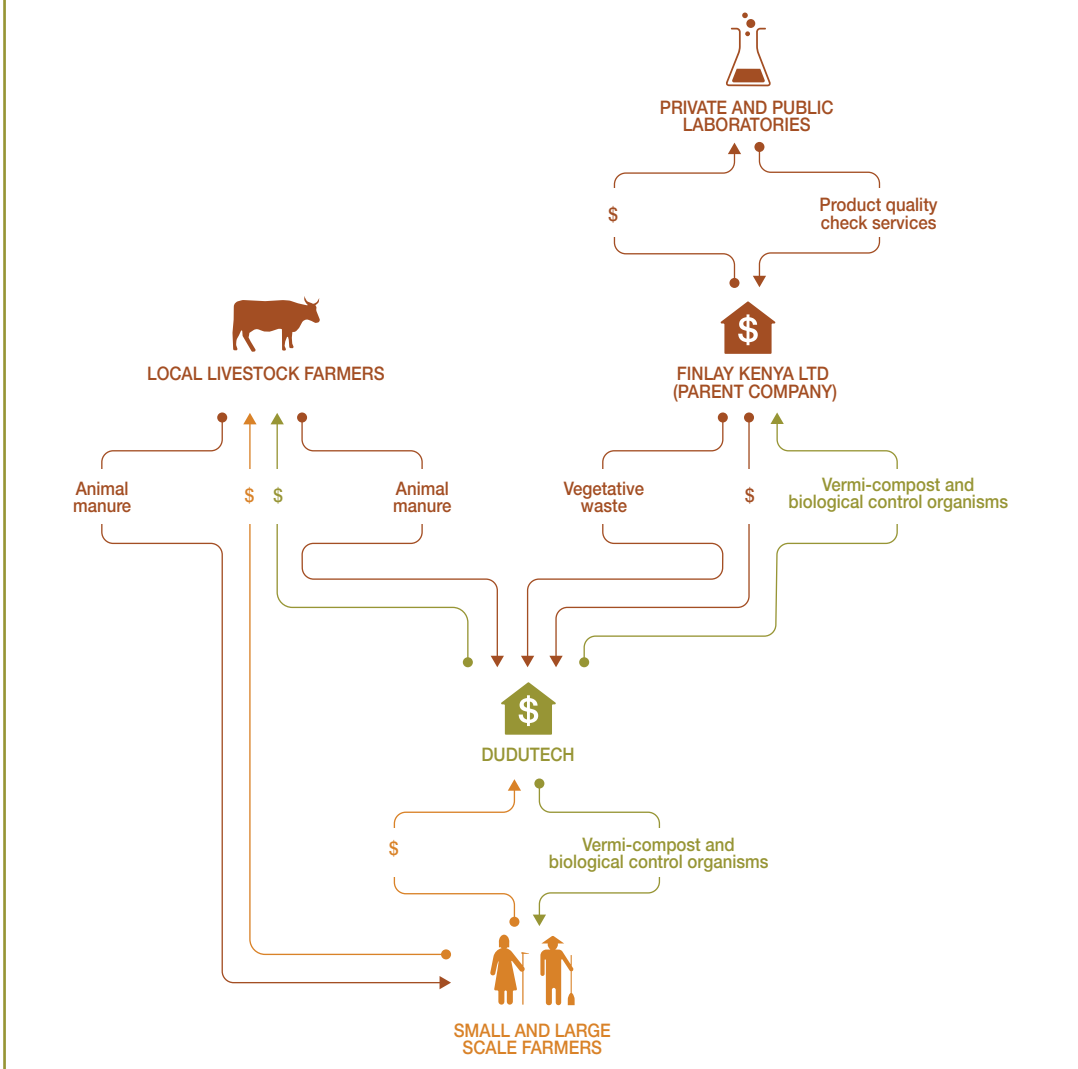
SOCIAL & ENVIRONMENTAL COSTS

- Possible contamination of soil and groundwater from disposal of untreated leachate on-farm

SOCIAL & ENVIRONMENTAL BENEFITS

- Job creation
- Reduction in chemical fertilizer use
- Reduction of carbon dioxide emissions
- Improvement in structure and nutrient composition of soil
- Management of animal and plant waste

FIGURE 168. DUDUTECH'S VALUE CHAIN



replacement of some quantity of chemical fertilizer. However, Vermitech can be comparatively more expensive than chemical fertilizer given the relatively high application rates. Gaining additional share of the fertilizer market will require a more competitive product price. On the other hand, DuduTech's products are garnering great demand given the increase in global and local demand for organic products.

Institutional environment

Management of solid waste in Kenya in general is dealt with under several laws, by-laws, regulations and acts of parliament. As with DuduTech, in order to legally engage in composting activities on a business scale in Kenya, a waste management permit from the county council and waste recycler's permit from NEMA are a requirement and these are renewable on an annual basis. Additional regulations have been

set in place including the Occupational Safety and Health risk Act and the Factories Act (cap 514 of the laws of Kenya) to protect plant workers and for which Dudutech has to comply to. The main policy and regulatory bodies that are responsible for overseeing the operations of composting activities in Kenya are: the City Council, Local Authorities in the Ministry of Local Government; Kenya Bureau of Standards (KEBS) in the Ministry of Industrialisation; and the National Environmental Management Authority in the Ministry of Environment and Mineral Resources (Onduru et al., 2009). The City Council provides guidance on waste management practices (collection, transportation and safe disposal), zoning and licensing. KEBS is mandated to develop standards (product quality certification) and ensure compliance with such standards. In collaboration with Kenya Organic Agriculture Network, KEBS has developed standards for the use and marketing of compost and other organic inputs (Onduru et al., 2009). The standards being developed recognize three categories of compost: liquid compost (e.g. leachates from vermicomposting), pelletized/granulated compost and natural/solid compost. KEBS' activities in particular will enable businesses like DuduTech to brand their product and increase their share of the fertilizer market.

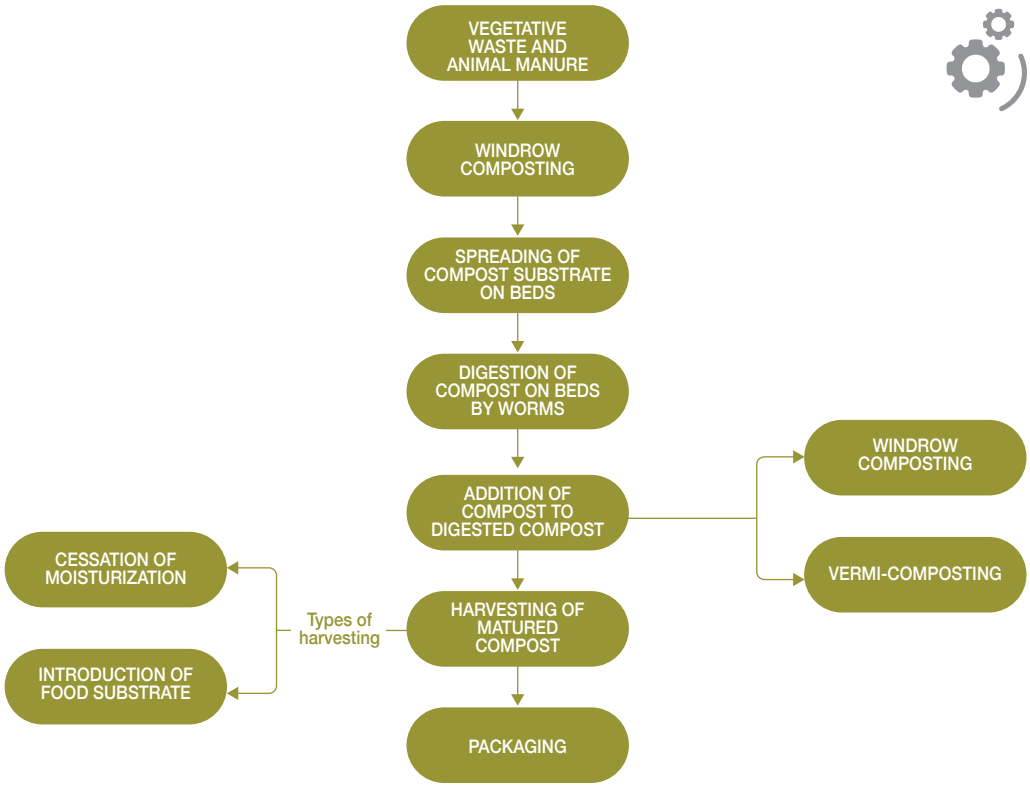
Technology and processes

DuduTech employs a combination of windrow and vermicomposting for the production of compost (Figure 169). A tractor fitted with trailers transports the vegetative waste from Finlays and a 10–20 ton lorry transports the animal manure from livestock producers to the production site. DuduTech uses both manual and mechanical methods for the vermicomposting process; however, plans are underway to mechanize other activities for its future expansion plans. Activities that are done manually include heaping, turning, watering and bagging. The equipment used is locally manufactured and spare parts are obtained locally. Danish International Development Agency (DANIDA) trained staff on vermicomposting and quality monitoring at the onset of the business. For the processing activity, vegetative waste is mixed with animal manure in the ratio of 1:2 and the mixture is composted for eight to ten weeks after which it is spread on beds to form a layer of ten centimetres. The beds are 45 meters long. As the substrate is digested by the worms, the volume shrinks and so additional waste is added in intervals to maintain the 10 centimetres depth until the vermicompost is mature for harvest. Once mature, there are two ways of harvesting. One way is discontinuing moisturization/ watering so that the worms move to the lower parts of the compost in search of water. Upper parts are scooped until all matured vermicompost is harvested. This is a dry harvesting technique and bagging can be done without having to re-dry the compost. The second harvesting technique involves creating a layer of food substrate on top of the matured vermicompost, separated by a net. This allows for easy separation between the matured compost and added food substrate but also permits the worm to access the food. Moistening continues until almost all the worms have penetrated the net into the substrate. The worms are harvested along with the food substrate, leaving only the vermicompost which is then harvested and dried to attain 40% moisture content then bagged for sale.

Funding and financial outlook

Initial capital cost comprising of land, equipment and other infrastructure was financed by DuduTech at a cost of USD 46,457 (4 million Kenyan Shillings). Total operational costs amount to USD 4,126 per month of which wage and salaries is the largest component, constituting 64%. Cost of waste input (largely acquisition costs of animal manure) accounts for 18%; and water, fuel and repairs each representing 3% of all costs. DuduTech earns revenues from the production and sale of biological control organisms and vermicompost. An annual profit of USD 7,000–8,500 is made from sales of vermicompost. Revenue and profit data were not disclosed for the sale of biological organisms.

FIGURE 169. PROCESS DIAGRAM OF DUDUTECH'S COMPOST PRODUCTION



Socio-economic, health and environmental impact

DuduTech's activities have resulted in several socio-economic and environmental benefits. DuduTech's business activities, particularly compost production, provide employment to 11 people on a regular basis. Furthermore, the use of vermicompost has contributed to the reduction of nitrates released into the soil and water bodies within and around the Finlay's farms from reduced chemical fertilizer usage. Although actual nitrates reduction figures were not provided, evidence of good agricultural practices can be attested to through Finlay's attainment of a Fair Trade Certification and receipt of premium prices for its agricultural products. Additionally, monetary gains are represented by cost savings from the use of Vermitech instead of chemical fertilizers by Finlays. Available data indicates that Finlays saves up to 20% in fertilizer costs and up to 30% in reduction of water used for irrigation. The conversion of vegetative waste to compost has also made available productive space which was originally used from disposal purposes. Improved livelihoods beyond benefits from reduced CO_2 emissions and groundwater contamination include increased revenues to livestock farmers from the sale of animal manure to DuduTech. DuduTech's operations, however, release raw leachate into the soil and water bodies. Plans are underway to add value to the leachate also for agricultural purposes. Health risks to workers are very low as any likelihood of exposure to pathogens from waste handling, for example, is mitigated from workers use of protective gear.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Provision of start-up capital by parent company, Finlays Limited – which mitigated capital investment risk.
- Assured supply of key production input (vegetative waste) at no cost.
- Diversified portfolio – which mitigates risk associated with fluctuations in market demand.
- Increasing international demand for (certified) organic produce.

DuduTech's model has a high replication potential especially in developing countries with increasing agro-processing businesses and related limited waste management options. An opportunity for the up-scaling of DuduTech's composting relates to the abundant vegetative waste produced by Finlays that is still being dumped untreated and used on farmlands. Increased production represents potential economies of scale that DuduTech can capture; which will help reduce its production costs and invariably lower product prices. This strategy will help capture a larger share of the fertilizer market. It is important to note however that adaptations to the production process may be necessary given increasing costs of labor and animal manure, in order to make the increase in scale of production monetarily worthwhile. The organic foods market in growing globally, suggesting a potential increase in demand for organic agricultural products for which DuduTech can additionally take advantage of.

Summary assessment – SWOT analysis

Figure 170 presents an overview of the SWOT analysis for DuduTech. Composting is a promising business in Kenya especially given the abundance of waste inputs and the growing need for environmentally sustainable agricultural input. DuduTech has been particularly successful in leveraging its business partnerships to mitigate capital investment risk and ensure consistent supply of waste inputs. Additionally, DuduTech implements a segmented pricing approach where it charges local farmers almost double the price its parent company, Finlays, pays. DuduTech produces a quality compost with high nutrient contents that is in high demand in spite of its comparatively higher market price. Its additional investment in quality assurance and monitoring by a third party has also enabled Finlays to produce certified organic products and obtain Fair Trade Certification. This certification brands products as those meeting internationally-set environmental and labor standards and thus receives higher market prices – from which Finlays has substantially benefited. The sustainability of DuduTech is however largely dependent on the parent company – Finlays Kenya Limited. Finlays provides raw materials at no cost and also buys 80% of the compost. Although unlikely, decreased demand from Finlays will significantly affect its profitability. Additionally, the technology currently in use is highly labor-intensive and any up-scaling initiatives without some changes to the technology process, exposes DuduTech to unpredictable labor costs. Despite these limitations, several opportunities exist for DuduTech to ensure sustainability: a) increase its scale of production to capture economies of scale; b) increase its market scope via the production and sale of leachate-based products; and c) sale of carbon credits through the establishment of a CDM project. DuduTech represents an example of an innovative business making use of its parent company's (Finlays) agricultural waste to ensure its sustainability whilst generating significant profits and benefits to society.

FIGURE 170. SWOT ANALYSIS FOR DUDUTECH

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Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2015/16. As business operations are dynamic data can be subject to change.

CASE

Enriched compost production from sugar industry waste (PASIC, India)

Miriam Otoo, Marudhanayagam Nageswaran, Lesley Hope and Priyanie Amerasinghe

Supporting case for Business Model 13	
Location:	Pondicherry (Puducherry), India
Waste input type:	Sugar mill organic waste
Value offer:	Provision of enriched pressmud compost for agricultural production
Organization type:	Public
Status of organization:	Operational since 1996
Scale of businesses:	Processes 6,000–9,000 tons of waste/year
Major partners:	Puducherry Cooperative Sugar Mills (PCSM), Agricultural Department of the Government of Pondicherry; Government of India

Executive summary

The Pondicherry Agro Service and Industries Corporation Limited (PASIC) is a government-owned agricultural inputs producer and supplier. Seeing an opportunity with producing enriched pressmud compost from sugar mill waste and effluent water, PASIC set up a compost production arm to its business in partnership with the Pondicherry Cooperative Sugar Mill (PCSM) – the largest industrial unit in the cooperative sector under the Pondicherry government to process their waste. PCSM's inefficient disposal practices were adversely affecting groundwater quality and polluting surrounding areas. Thus, this partnership represented a win-win for both parties – PCSM was able to continue their operations according to legislative guidelines and PASIC produced and sold a nutrient-rich organic fertilizer to farming communities. The business arrangement is such that profits are split equally between both parties. PCSM provides the waste input to PASIC free of charge and provides the land for the processing of the waste. PASIC on the other hand covers all other capital and recurrent costs and has a budget of USD 45,600 per year. The corporation has so far created 25 jobs to benefit local workers and their families. The corporation deliberately keeps its annual net profit low at 5–7% given its social orientation. The compost, which is heavily subsidized by the agricultural department, is sold in agricultural depots and outlets. A 75% subsidy scheme is provided for farmers and 100% for Schedule Caste (SC) farmers. The project has significantly contributed to the peri-urban economy and safeguarded the health of local water bodies and environment in general. Beyond this, the increased adoption of organic fertilizer will contribute to the reduction of imported chemical fertilizer and related government subsidy expenditures.

KEY PERFORMANCE INDICATORS (AS OF 2015)						
Land use:	2.43 ha					
Capital investment:	USD 75,000 including cost of 2.43 ha of land					
Labor:	25 people (9 skilled and 16 unskilled)					
O&M cost:	USD 49 per metric ton					
Output:	3,000 tonnes of enriched pressmud compost / year					
Potential social and/or enviornmental impact:	Creation of 25 jobs, reduction in groundwater and land pollution, waste management cost savings and improved environmental health					
Financial viability indicators:	Payback period:	8 years	Post-tax IRR:	N.A.	Gross margin:	5–7%

Context and background

Pondicherry Agro Service and Industries Corporation Limited (PASIC) is located in the southern part of peninsular India, which is a Union Territory. It was incorporated in 1986 and is owned by the Government of Pondicherry. The main activity of the Corporation is to distribute agricultural inputs such as fertilizers, seeds, organic fertilizer (enriched pressmud and municipal solid waste-based compost), plant protection equipment, horticultural plants, implements, tools, bio-fertilizers etc., to the farming communities at a reasonable price. In 1996, PASIC and the Pondicherry Co-operative Sugar Mills Limited (PCSM), entered into a joint venture for the processing of sugar mill waste to an enriched pressmud compost. This became necessary due to the difficulty experienced by PCSM with the disposal of its sugar mill waste. Each processed ton of crushed sugarcane produces between 0.16 to 0.76 m^3 of wastewater. PASIC processes about 6,000 to 9,000 tons per annum of pressmud and effluent from PCSM units. The sugar mill's wastewater has excessive amounts of suspended solids, dissolved solids, BOD, COD, chloride, sulphate, nitrates, calcium and magnesium, creating significant deleterious effects to both water bodies and soil when disposed of untreated. PASIC also took advantage of the increasing chemical fertilizer prices and need for sustainable agricultural inputs alternatives and established a sound and viable reuse business.

Market environment

Government expenditures on chemical fertilizer imports for agricultural production are at an all-time high and on an increasing trend in India, in an effort to increase agricultural production. Government subsidies on chemical fertilizer have however resulted in inefficient use by agricultural producers. Over-application and extensive use of chemical fertilizers has had a dilapidating effect on agricultural soils and resulted in less productive yields. The demand for more sustainable agricultural input alternatives coupled with the increasing awareness of organic farming are some of the factors that PASIC capitalized on in setting up the business enterprise. In addition, there was the need to properly manage the waste generated by the sugar mill industry which had become a source of land and water pollution. India has a gross cropped area of 190 million hectares and would require about 627,000,000 tons/year of enriched pressmud compost to cover this agricultural production area. There are 600 sugar factories crushing 145 million tons of sugarcane annually in the country. The annual by-products generated through these industries are about 5 million tons of pressmud/year. This is indicative of a potential demand that will be greater than supply, assuming there are mechanisms in place to incentivize adoption by farmers. Organic fertilizer businesses face fierce competition in the fertilizer market from chemical fertilizer and other organic fertilizer businesses. The enriched pressmud compost produced by PASIC is heavily subsidized by the government – 100% subsidy for schedule caste farmers and 75% for general farmers. Additionally, although PASIC is socially-oriented, its profit margin remains positive and regulated between 5–7%. These measures have given PASIC a

competitive advantage over other new market entrants (organic fertilizer producers) and chemical fertilizer. PASIC produces and sells about 3,000 tons of enriched pressmud compost, accounting for 90% and 15% of the compost and chemical fertilizer markets respectively in Pondicherry. Although PASIC's compost is fairly substitutable with other organic fertilizers, the relatively low price of USD 0.01/Kg and its high nutrient content (N: 1.24%, P: 2.77, K: 1.68%, OC: 21.6%, Mg: 0.95% and Zn 0.012%) give it an edge over other products.

Macro-economic environment

The Indian government highly subsidizes chemical and synthetic fertilizers, particularly Nitrogen, Phosphorus and Potassium (NPK). The amount of subsidies on chemical fertilizer has grown exponentially in the last few decades and has been mainly attributed to inflation and price fluctuations in the international market (Mishra and Gopikrishna, 2010). Significant subsidy allocation has not only led to inefficient use by farmers and high costs to the government; substantial soil degradation has also been observed as a result. With a growing need to increase the availability and quality of bio-fertilizers and composts in the country to improve agricultural productivity while maintaining soil health and environmental safety, the Indian government has set up over the last few years new schemes to augment the infrastructure for production of quality organic and biological inputs, and also from organic municipal waste.

A capital investment subsidy scheme for compost production has been introduced under the National Mission for Sustainable Agriculture (NMSA). The scheme provides 100% financial assistance to state governments and government agencies up to a maximum limit of about USD 300,000 per construction unit, and for individuals or private companies up to about USD 100,000 per unit (max 33% of project costs) through the National Bank for Agriculture and Rural Development (NABARD). Moreover, the Government of India is providing a Market Development Assistance of about USD 23.4 per metric ton to Fertilizer Companies for sale of City Waste Compost (Ministry of Agriculture, 2017). Policies to reduce the budget allocation for chemical fertilizers and provide capital investments for new and existing compost businesses are important instruments that catalyze the business development in the RRR sector and the scaling-up of initiatives similar to that of PASIC.

Business model

PASIC undertook a long term (99-year) agreement with PCSM to process the sugar mills' waste into an enriched pressmud compost (Figure 171). PASIC is funded by the government of India; and produces and sells enriched pressmud compost to farmers directly through agricultural depots. It implements both a value-driven and a price-driven sales strategy, and a segmented market approach, selling enriched pressmud compost at a higher price to urban horticulturist than general farmers who represent 99% of its customer base. This is because, although PASIC's compost is fairly substitutable with other organic fertilizers, the relatively low price of USD 0.01/Kg and its high nutritive value (N: 1.24%, P: 2.77, K: 1.68%, OC: 21.6%, Mg: 0.95% and Zn 0.012%) gives it an edge over other products. Essential in its business model is PASIC's partnership with PCSM and the Indian Government via the agricultural department. It partners with PCSM for the continuous supply of waste at no cost. In addition, all production activities are executed on PSCM's production site to reduce investment costs (land purchase) and transportation costs thereby reducing overall production costs. PASIC manages and covers all costs associated with the production unit, technology, manpower, and production and marketing activities of the processed pressmud. PASIC does not compensate PCSM for the raw materials as it carries out the task of value addition of waste and disposal. Profits are shared on a 50:50 basis between PASIC and PCSM. The partnership with the government mainly is for easy marketing of products through price subsides provided to farmers. The government of Pondicherry through agricultural department annually allocates budget for the distribution of the pressmud compost

FIGURE 171. PASIC'S BUSINESS MODEL CANVAS

KEY PARTNERS

- Pondicherry Cooperative Sugar Mills
- Government of India
- Agricultural department of the Government of Pondicherry

KEY ACTIVITIES

- Treatment of organic solid of sugar industry and effluent water
- Processing of pressmud compost
- Transport and distribution to agricultural depots
- Marketing and sales

KEY RESOURCES

- Free Sugar mill organic waste
- Land as included in the partnership deal
- Labor (25 workers), equipment
- Long-term agreement with PCSM

VALUE PROPOSITIONS

- Local farmers obtain a nutrient-rich, enriched pressmud compost at a reasonable price
- Provision of sustainable waste management alternative for agro-processing units

CUSTOMER RELATIONSHIPS

- Personal and direct sales
- Use of direct personal help for long-term agreement with PCSM

CHANNELS

- Direct sales through agricultural depots

CUSTOMER SEGMENTS

- Farmers
- Urban horticulturists
- Pondicherry Cooperative Sugar Mills

COST STRUCTURE

- Capital investment (excluding cost of land)
- O&M cost
- Cost for quality control noted to be the lowest O&M cost; and input costs for micronutrients and enriched materials been the highest.
- Profit sharing with PCSM
- Transport cost (only for product delivery thanks to partnership)
- Marketing and sales

REVENUE STREAMS

- Sale of enriched pressmud compost

SOCIAL & ENVIRONMENTAL COSTS

- None noted based on information provided

SOCIAL & ENVIRONMENTAL BENEFITS

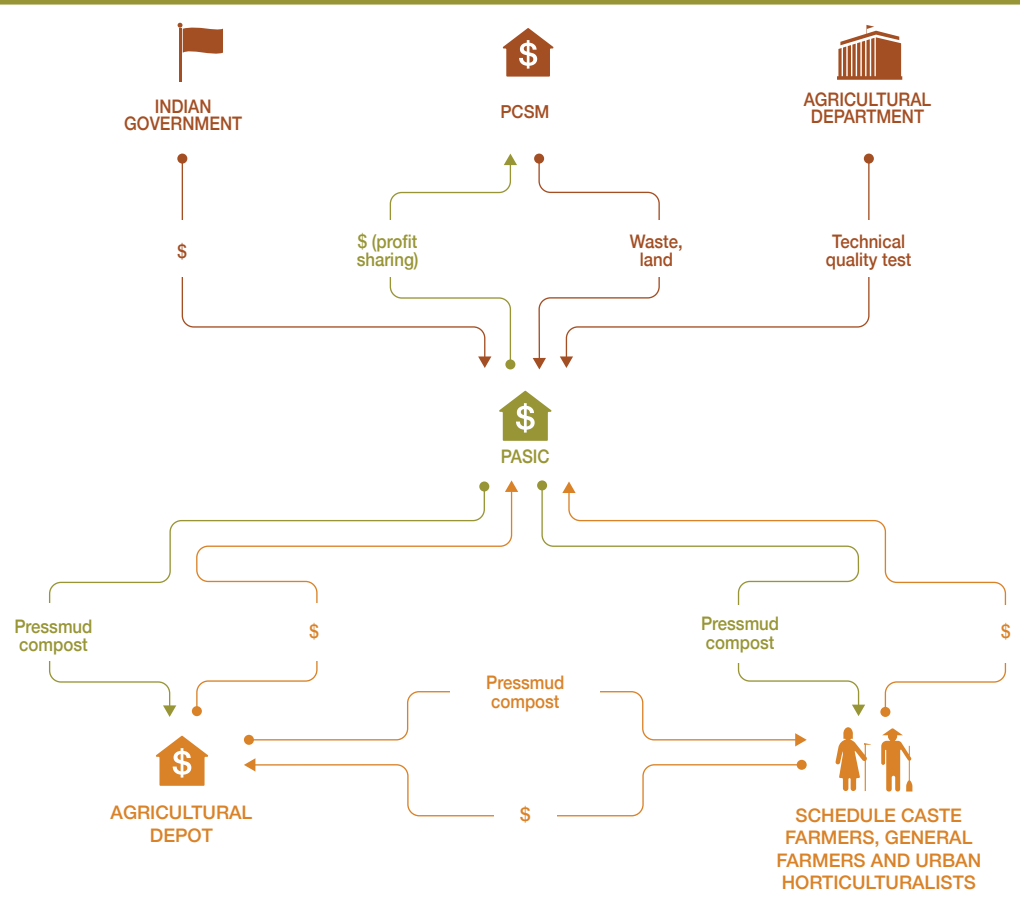
- Reduction of waste from sugar mill industry
- Job creation
- Reduced pollution of water bodies from sugar mill effluent
- Reduced existing waste management costs
- Reduced human exposure to untreated waste pollutants
- Enhance soil fertility and productivity
- Reduced GHG emissions

to farmers and also offers a 75% and 100% price subsidy to general and schedule caste farmers respectively. With the adoption of a social-oriented approach, profit margins are deliberately kept low and have been fixed at 5–7% by the government of Pondicherry. This in addition to the subsidies provided has made the product affordable to majority of farmers. These partnerships enable PASIC to maximize its profits in spite of a profit ceiling, obtain a regular supply of raw materials and also create an assured market for the enriched pressmud compost product.

Value chain and position

PASIC's key business activities are the production, marketing and sale of the pressmud compost (Figure 172). The value chain is very simplistic and has PASIC as the key player. PASIC sources its raw materials from PCSM and is the sole user of the 6,000–9,000 tons of sugar mill waste generated per year. Given the long-term agreement between these two parties, PASIC faces no competition with any other company for raw materials and has an assured supply of inputs. PCSM, in addition, provides the space and facilities for the processing operations of pressmud compost. PASIC in turn covers all remaining operational costs and the profits are split equally between the two parties. PASIC

FIGURE 172. PONDICHERRY AGRO SERVICE INDUSTRIES CORPORATION LIMITED'S (PASIC) VALUE CHAIN



was funded by the Indian government at a cost of USD 75,000 excluding land costs, and provides significant subsidies to farmers. These subsidies have eased PASIC's entry into the fertilizer market in the face huge competitors such as chemical fertilizers who own a large share on the market. The agricultural department provides technical expertise for the laboratory analysis of compost to ensure that the pressmud compost is a safe and nutrient-rich product. PASIC is sold directly to farmers and also through agro-outlets and agricultural depots. PASIC has been able to capture a significant share of the organic fertilizer market in Pondicherry mainly due to using the agricultural depots via its partnerships with the agricultural department and government subsidies.

Institutional environment

At the local government level, the Pondicherry Government has been very supportive of the business activities of PASIC. In addition to putting up the start-up capital for the business, it annually makes a budgetary allocation for the distribution of the pressmud compost under a 75% subsidy scheme for general farmers and 100% subsidy for schedule caste farmers via the Department of Agriculture. The subsidy scheme has been essential for PASIC in gaining an easy enty into the fertilizer market. At the country level, there is a statutory guideline – the Fertilizer Control Order (FCO) instituted by the Ministry of Agriculture and Rural Development for the production and distribution of all fertilizers including organic fertilizer. Product quality recommendations are provided for different organic fertilizer types for which producers have to adhere to. This is particularly beneficial to farmers as they get what they are paying for, but also for compost businesses as they are able to build their product brand.

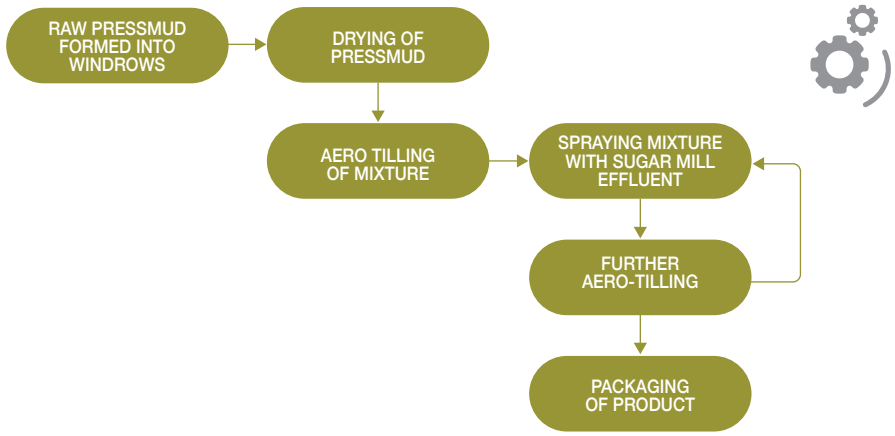
Technology and processes

Composting of pressmud is carried out using an aerobic decomposition of pressmud in windrows (Figure 173). Most of the processing equipments are simple and locally manufactured, making them more cost-efficient. The technology has a waste input–output conversion ratio of about 30%. Decomposition is accelerated by inoculation of microbial cultures and the provision of required fermentation optima (maintenance of optimum moisture, aeration and temperature). The composting process takes between 45 to 70 days, after which the decomposed material is mixed with other products listed in Table 42 to produce the enriched compost. The majority of these organic materials are produced by PASIC. For the aerobic composting process, raw pressmud is formed in windrows and dried for three to four days to reduce the moisture content. With an aero-tiller, the product is aero-tilled once in three days. The sugar mill effluent is sprayed on the product when the moisture level reaches 50%, and the process of aero-tilling is carried out again. This process is repeated for 60 days. The product is then enriched with bio-fertilizers and micronutrients through spraying over the windrows. This mixture undergoes the aero-tilling process to ensure a uniform mixture. The final enriched pressmud compost is then packed into 50kg high density polyethylene bags. The cost for

TABLE 42. TYPE AND QUANTITY OF PRODUCTS ADDED TO ENRICH THE PRESSMUD COMPOST PRODUCT

NAME OF THE NUTRIENTS	QUANTITY PER 10 TONS OF PROCESSED COMPOST
Rock phosphate	200 kg
Azospirillum broth	10 litres
Phosphobacterium broth	10 litres
Pseudomonas broth	10 litres
Magnesium sulphate	75 kg
Zinc sulphate	75 kg

FIGURE 173. PROCESS DIAGRAM FOR PRODUCTION OF PASIC'S PRESSMUD COMPOST



quality control is noted to be the lowest O&M cost, with input costs for micronutrients and enriched materials been the highest. Micronutrients and enriched materials cost is about USD 8.81 per ton of enriched pressmud compost, accounting for almost a fifth of per unit operational cost.

Funding and financial outlook

PASIC is a public company established by the government of Pondicherry at a cost of USD 75,000 excluding land costs, with a payback period of eight years. There are no land costs to PASIC as all plant operations take place on the PCSM production site as part the established long-term agreement. PASIC has an average production capacity of 3,000 tons per annum. The average production cost of the enriched pressmud compost is USD 49 per ton, with labor costs comprised of wages, salaries and management cost accounting for 45% of the total operation cost. PASIC covers all costs related to technology, manpower, production and marketing of the enriched pressmud compost. Profit margins are estimated at 5–7% and with 50:50 sharing system between PASIC and PCSM – annual profit per entity of USD 7,900. Sales from enriched pressmud compost and waste management fees paid by PCSM are the revenue streams for PASIC. Twenty-five percent of the compost sale price is paid by farmers and the rest is paid for by the state government (i.e. Pondicherry government) through the agricultural department. Plans are underway to have enriched pressmud compost sold in other states.

Socio-economic, health and environmental impact

The business activities of PASIC have reduced the purchase of chemical fertilizer and subsequently led to enhanced sustainable crop production. In the last sixteen years, PASIC has processed about 1.46 million tons of sugar mill waste into about 444,350 tons enriched press mud compost. Applying a nominal value of USD 56 per ton to the waste, the project has generated approximately USD 2.56 million in "new waste to value" to the community. The project will continue to produce approximately 3,000 tons of packaged enriched pressmud compost annually, resulting in an increase in rice yields of 1,067 tons equivalent to about USD 0.25 million. This project has reduced environmental pollution due to unregulated disposal of untreated sugar mill waste which hitherto was a major problem. It has and continues to safeguard the health of local water bodies and soil health. It has also improved the livelihoods of the local community through the provision of jobs. The project supports 25 jobs and has a budget of USD 45,600 per year to benefit to local workers and their families. Additionally, PASIC

ensures to safeguard the health of its workers through the provision of safety gear – hand gloves and rubber boots and annual medical check-ups.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Strong commitment of the state government in providing an enabling environment for the implementation of the business via the provision of start-up capital and price subsidies.
- Strong partnerships with the agricultural department provided key technical expertise to produce a high quality product and easy access to customers via its agricultural depots.
- Long-term contractual agreement with PCSM (agro-processing unit) ensures continuous supply of waste input and premises for plant operations.
- Policy initiatives to phase-out chemical fertilizer subsidies and capital investment subsidies to new and existing compost businesses.
- Environmental legislation making waste treatment a requirement.
- Government scheme set up to augment the infrastructure for production of quality organic and biological inputs.
- Local government supportive of the business initiative.

PASIC's model has a high replication potential in agrarian developing countries with large agro-processing units. Initial governmental support will be required to mitigate capital investment risk and gain entry into an oligopolistic fertilizer market. The contractual agreement between PASIC and PCSM on use of all the sugar mill's waste and premises for processing activities, eliminates transportation costs and land rent (implying higher profits) which have been known to be substantial costs incurred by organic fertilizer producers. PASIC, however, faces a profit margin ceiling which prevents over-pricing but also the maximization of profits. This business has a social focus and its pricing model may not be applicable to a profit-oriented business. Out-scaling of PASIC's model will increase the costs of production proportionately more than the generated revenue, thus governmental support at least at the start-up stage will be required in replicating this model. It would be ideal for the sugar processing companies to contribute to the investment cost in addition to the land cost in the instance where government support is lacking.

Summary assessment – SWOT analysis

Figure 174 presents the SWOT analysis for PASIC. Composting is a promising business in India especially given the abundance of waste inputs and the growing need for environmentally sustainable agricultural input. PASIC has been particularly successful in leveraging its business partnerships to mitigate capital investment risk and gain entry into a fiercely competitive fertilizer market. Additionally, PASIC implements a segmented pricing approach where it charges urban horticulturists more than it does peri-urban and rural farmers. The sustainability of this business is however largely dependent on price subsidies provided by the government. The removal of these subsidies may expose PASIC to fierce competition in the fertilizer market, in which case it would have to rebrand its product to maintain its market share. Increasing governmental support along with growing demand for organic fertilizers will represent key opportunities for replication and up-scaling of the business. The use of a simple technology has been important to the business' success – taking advantage of cheap labor, however with increasing wages and energy prices, PASIC will have to consider other alternatives with future expansion plans. PASIC is an example of an innovative waste reuse business utilizing a simple partnership approach to address some of the major waste management and environmental challenges in Pondicherry, India.

FIGURE 174. SWOT ANALYSIS FOR PASIC

Contributors

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CASE

Livestock waste for compost production (ProBio/Viohache Mexico)

Javier Reynoso-Lobo, Miriam Otoo, Lars Schoebitz and Linda Strande

Supporting case for Business Model 13	
Location:	Culiacan, Sinaloa, Mexico
Waste input type:	Agro-waste (livestock waste)
Value offer:	Organic fertilizer – compost and nutrient-rich liquid fertilizer from processed leachate
Organization type:	Private
Status of organization:	Operational since 2003
Scale of businesses:	Large-scale processing 420,000 tons of animal waste per annum
Major partners:	SuKarne

Executive summary

Productos Bioorganicos (ProBio) is Mexico's largest compost and vermicompost producer with the well-known Humibac brand. Although recently, its name changed to Viohache, this presentation is still using "ProBio". ProBio is a private company created in 2003 to manage the animal waste generated by SuKarne – the largest beef producer and marketer in Mexico. Given the significant quantities of livestock waste produced by SuKarne, traditional waste disposal (i.e. landfilling) systems no longer seemed sustainable and the identification of viable and environmentally safe alternatives was imperative. ProBio maintains a strategic partnership with SuKarne by providing pen-cleaning services in return for their feedstock – animal waste. The business processes 420,000 tons of livestock waste per annum to produce a total of 231,000 tons of compost and 500,000 liters of nutrient-rich liquid fertilizer from processed leachate. It operates in five locations around the country, and supplies a low cost, high quality organic fertilizer to the vegetable, fruit and grain crop sectors. ProBio implements a commodity-value based business model by using simple, low-cost and innovative strategies for the production and branding of the products they offer. It has garnered significant market demand through third party certification and the tailoring of its products to specific clients and agricultural purposes. The business also takes advantage of economies of scale and focuses on low cost, yet efficient technologies for organic fertilizer production and improved waste management. ProBio's operations have had a strong impact on society and the environment as its activities contribute to the reduction of greenhouse gas emissions, on-site waste odor, groundwater and surface water contamination, agricultural crop burning, and local air and soil pollution, among a few.

KEY PERFORMANCE INDICATORS (AS OF 2015)						
Land use:	130 ha					
Capital investment:	USD 6,410,000 (land – USD 600,000; infrastructure – USD 377,240; machinery – USD 5,130,000; R&D – USD 100,000)					
Labor:	65 employees					
O&M costs:	USD 2.5 million per year					
Output:	231,000 tons of organic compost and vermicompost, 500,000 liters of nutrient-rich liquid fertilizer from processed leachate per annum					
Potential social and/or enviornmental impact:	Reduction of methane and CO_2 emissions, waste odor, groundwater contamination, local air and soil pollution, fertilizer requirements and improvement of agro-industrial waste management systems					
Financial viability indicators:	Payback period:	5 years	Post-tax IRR:	N.A.	Gross margin:	USD 1.9 million

Context and background

Grupo Viz is a family-owned business established in 1969 at Culiacan, Sinaloa, Mexico. Over the years, Grupo Viz has expanded its operations to other sectors of the cattle production value chain and now owns five subsidiary companies operating independently. The five subsidiaries of Grupo Viz are:

a) SuKarne, a beef, poultry and pork producer;
b) ProBio, dedicated to the production of organic compost and vermicompost from animal waste;
c) Rendimientos Proteicos (RenPro), specialized in the processing of tallow, meat and blood meals for livestock and animal feed production;
d) SuKuero, a leather commercialization business; and
e) Agrovizion, an agribusiness dedicated to the promotion and commercialization of agricultural products such as corn, wheat, oats and roughage.

At the time of assessment, SuKarne owned five production facilities around the country, located in the states of Nuevo Leon, Baja California, Michoacan, Durango and Sinaloa. These five facilities maintain a daily average of 425,000 animals confined in open feedlots through the year. As the largest beef producer in Mexico, it significantly contributes to the generation of animal waste both nationally and worldwide. The national and local state legislation prohibit the unlicensed disposal and/or uncontrolled burning of animal waste, which results in significant quantities of waste that are left to decay in open-air landfills. This contributes to the production of large amounts of methane from the anaerobic process of landfilling, and invariably contributing to greenhouse gas (GHG) emissions. The above situation triggered the creation of ProBio in 2003, an independent private company with the objective of incorporating an efficient waste management solution for SuKarne's feedlot operations. The animal waste is removed from the feedlots at their facilities once every 6 months by ProBio and is processed into compost and vermicompost, a total of 231,000 tons per annum (70 and 30%, respectively), and an additional 500,000 liters of nutrient-rich liquid fertilizer from processed leachate. As SuKarne is the company's waste provider, this makes ProBio by far the largest compost and vermicompost producer in the country.

Market environment

According to the Mexican Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food ("SAGARPA"), 58% of Mexico's land, a total of 113.8 million hectares, is used for beef production. There is a total of 31 million cattle livestock in Mexico owned by 1.13 million breeders: 2 million dairy cattle and 29 million beef cattle (SAGARPA, 2015). According to the Mexican Ministry of

Environment and Natural Resources "SEMARNAT", livestock production has shown an accelerated growth in the past two decades, increasing by 62% in comparison with the 90's (SEMARNAT, 2010). As a result of this progressive increase in the agricultural sector, 83% of its emissions were accounted to livestock production in 2002, equivalent to 8% of the total emissions in Mexico. Additionally, waste management systems currently adopted no longer seem sustainable. There is a growing need for environmentally sound waste management alternatives, particularly in the livestock sector, given increasing enforcement of legislative mandates related to environmental protection.

A key factor driving the development of businesses such as ProBio is increasing chemical fertilizer prices and a need for sustainable agricultural alternatives. Soils in Mexico have a high susceptibility to erosion especially in the high valleys, which are mostly formed from volcanic materials (with a high concentration of sand and silt). Farmers favor fertilizers that facilitate plant nutrient assimilation at soil level and promote the formation of mycorrhizae and root absorption. These factors are indicative of the increasing demand for organic fertilizers and in general the development of more waste reuse businesses in Mexico.

Macro-economic environment

The increasing demand in higher food safety standards and organic products has triggered an increased use of vermicompost as high quality soil conditioner in several regions across the world. Since the 90's, the global market for organic food products has grown rapidly, reaching US $63 billion worldwide in 2012. This demand has driven a similar increase in organic agricultural inputs, including fertilizers (Willer et al., 2013). Mexico is estimated to have more than 110,000 organic farmers, considered the greatest number in any country worldwide. As demand for organic food in the United States expands, Mexico's certified organic acreage has been growing at a rate of 32 percent per year. A 2009 study found an annual organic production value of more than $370 million with 80% destined for export (Agri-Food Trade Service, 2009). Nutrient management has also become increasingly relevant with the price increase of chemical fertilizers and their inherent accountability for human health issues and environmental contamination. To date, there are few organic fertilizer producers in Mexico with large-scale capabilities – most producers constitute small operations. Affordable organic fertilizers have strong market potential for Mexico in the agricultural sector.

Business model

Figure 175 summarizes ProBio's business model. By using simple and low-cost yet effective technologies, ProBio produces high quality organic fertilizers tailored to specific customer segments and agricultural purposes. This, in addition to third-party product certification has garnered significant market demand. Its three main products, compost, vermicompost and nutrient-rich liquid fertilizer from processed leachate are sold directly to vegetable, fruit and grain crop farmers. Product promotion is achieved through field demonstrations and pre-commercial tests and have been instrumental in creating greater market access. A key aspect of ProBio's model is its partnership with SuKarne, an important waste generator. Initially, ProBio established an agreement with SuKarne to provide pen-cleaning services in exchange for the waste and a small fee. Additionally, SuKarne aided ProBio financially in order to start up the business as establishing a waste management system was a pressing issue for the beef producer. Nowadays, ProBio is a well-established profitable business and no longer charges SuKarne pen cleaning fees. Close proximity of ProBio to SuKarne's plant operations eliminates significant transportation and labor costs associated with the acquisition of waste. Yet, transportation and waste collection costs constitute the largest share of all operational costs at 68%. ProBio has recently restructured its business model and made a significant investment in machinery and increasing operative personnel as most equipment and required resources for operative activities were initially outsourced. This will significantly reduce O&M costs and yield higher long-term margins.

FIGURE 175. PROBIO'S BUSINESS MODEL CANVAS

KEY PARTNERS

- SuKarne
- Certification partners

KEY ACTIVITIES

- Liaison with government and other entities
- Provide pen cleaning services
- Collection of animal waste
- Production and sale of compost, vermicompost and liquid fertilizer from processed leachate
- Product tailoring
- Brand management, marketing and sales

KEY RESOURCES

- Quality assurance laboratory
- Waste input
- Machinery and equipment
- Irrigation system
- Operators
- Technical sales personnel
- Pest free certificates
- Brand
- Contractual agreement

VALUE PROPOSITIONS

- Offer tailored, low price compost, nutrient-rich vermicompost and liquid fertilizer
- Provision of sustainable waste management options for livestock producers

CUSTOMER RELATIONSHIPS

- Sales staff advise farmers and promote the products via technical workshops, field demonstrations, semi commercial tests
- Long-standing business relationship

CHANNELS

- Direct and indirect (telephone) sales
- Radio and web advertisement

CUSTOMER SEGMENTS

- Vegetable and extensive crop farmers)
- SuKarne

COST STRUCTURE

- Capital investment of USD 6.4 million (land, infrastructure, equipment, machinery, R&D)
- O&M costs of USD 2.5 million per annum

REVENUE STREAMS

- Compost and vermicompost sales

SOCIAL & ENVIRONMENTAL COSTS

- Dust generation from daily activities

SOCIAL & ENVIRONMENTAL BENEFITS

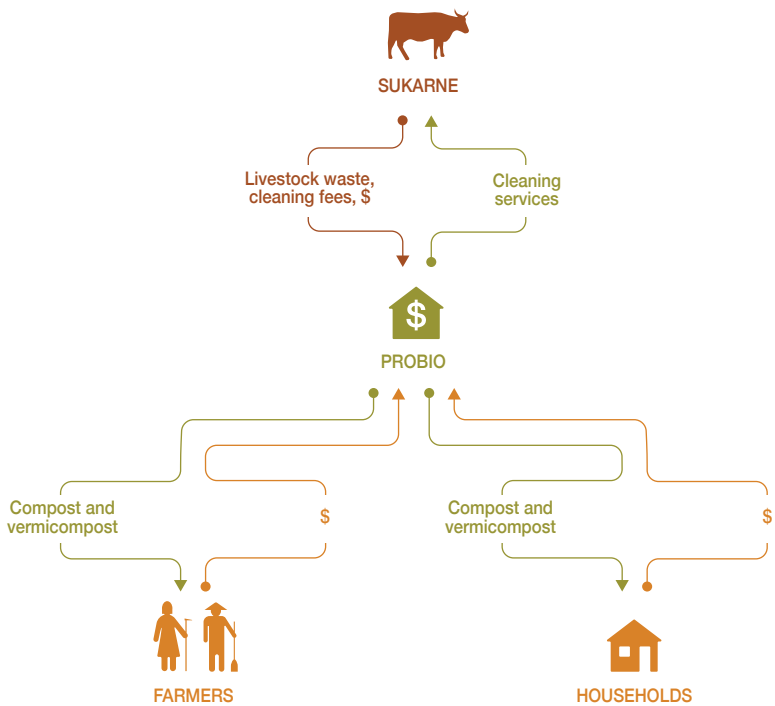
- Job creation
- Reduction of methane and CO2 emissions, waste odor, groundwater contamination, local air and soil pollution
- Reduction of chemical fertilizer requirements for agriculture
- Improvement in livestock waste management
- Improved soil quality

ProBio has demonstrated that waste reuse businesses can be profitable with government support and generate significant benefits to both industry and society. The next step for ProBio is set to be a more technological and innovative-based business, already with available technologies being tested at pre-commercial stages.

Value chain and position

ProBio's value chain is depicted in Figure 176. It benefits from SuKarne's capability to provide constant and large volumes of animal waste (feedstock), which enables the company to produce significant quantities of organic fertilizer. ProBio also takes advantage of other waste streams such as leftover corn stover and paunch from SuKarne's feed mill and slaughterhouse to use them as nutrient additives into their process. Such scale allows ProBio to develop optimization strategies in order to maximize its efficiency and increase profit margins. Through its economies of scale, both compost and vermicompost are priced significantly lower than the competition's products, mainly chemical fertilizer and smaller organic fertilizer producers, and thus providing an important competitiveness factor. Product demand relies on two customer segments, the vegetable and extensive crop farmers; the latter particularly expected to grow given the increasing demand for organic food products. ProBio has a strong sales team that is strategically divided by regions with important agriculture operations, where they establish product promotion programs with local farmers.

FIGURE 176. PROBIO VALUE CHAIN



Institutional environment

Livestock production units are bound by the Mexican Official Standard 001, which sets forth the maximum limits of solid and liquid waste allowed to be disposed of and discharged to federal water channels or bodies, respectively. This standard has forced livestock producers to develop waste management systems to meet those maximum limits, especially in the face of increasing production scales. This regulation implicitly incentivizes livestock companies to invest in businesses like ProBio to ensure their compliance and sustainability. Whilst there are no specific governmental guidelines for the certification of compost, several internationally accredited third party certification entities exist (e.g. Bioagricert and Metrocert) in Mexico. Product certification conveys a message of assured product quality to consumers (assuming they trust the certification body), which enables entities such as ProBio to increase their credibility and market share.

Technology and processes

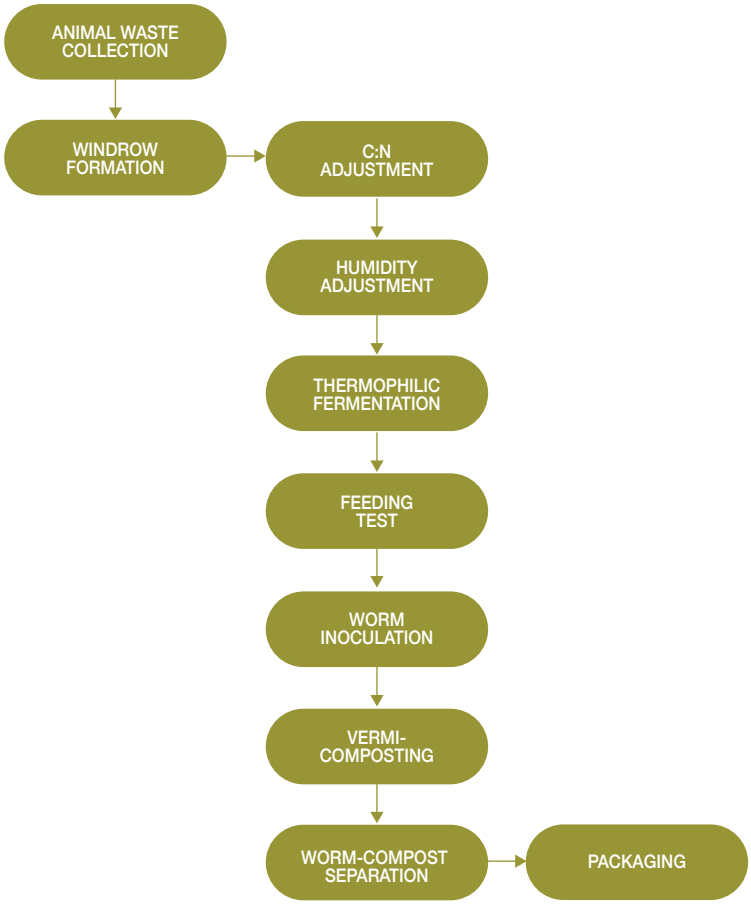
Figure 177 provides an overview of the technological processes used by ProBio for the production of its organic fertilizers. The animal waste is collected from the feedlot pens every 6 months using a scraping system and stockpiled near their operations. Waste is constantly removed from this pile to enter the composting process. For such a process, windrows of 200 m length × 6 m wide × 3 m height of animal waste are formed, and corn stover and some paunch is added to the mixture to adjust for carbon and nitrogen requirements. Additionally, water is added to reach optimal humidity content for the fermentation process to start (this takes about a week). This part of the process undergoes an aerobic thermophilic fermentation stage for about 8 weeks, where temperatures of up to 70ºC are reached and promote pathogen elimination. Further aerobic degradation is achieved throughout an approximate 14-week mesophilic stage where temperature drops to 25–30ºC to enter a final compost maturation stage. Finally, the compost is screened to remove stones and other unwanted particles. The overall composting process lasts from 120–160 days.

Finished compost is utilized to feed the vermicomposting process. New windrows are formed and California Redworms (Eisenia fetida) are added. The redworms further contribute to the organic matter degradation, producing a compound called 'humus', or vermicompost, a nutrient-rich organic fertilizer with important soil conditioning properties. Once the worms are well established, additional compost is added weekly in order to "feed" them and increase the production of vermicompost. The windrows are watered every day through an automated irrigation system in order to maintain a humidity level between 60–70%. Windrows are placed over a sloped terrain to enable natural leachate collection throughout the process, where it is then pumped into large containers for further oxygenation and packaging. After a period of 5–6 months the worms are removed using a trommel and further reincorporated into a new vermicomposting process; the humus or vermicompost is finally screened and ready for sale. Both finished compost and vermicompost are analyzed to determine nutrients and other constituents. Overall, the whole process from waste to final product has a conversion efficiency of 55%. The final product contains a nitrogen, phosphorus and potassium content of 0.5–1%, 1–1.5%, and 1–1.5%, respectively, and provides a crop yield (tested e.g. for potatoes) increase of 15–30%.

Funding and financial outlook

The business required an initial capital of USD 2.2 million, for land, infrastructure, machinery and equipment. The payback period for such an investment is estimated at three years. Overall, the business has production costs of USD 5.5 million (Table 43), where 46% is accounted for operation and maintenance, which breaks down in the following way: 68% for transport and waste collection, 15% for machinery lease related to the composting and vermicomposting processes, 10% for equipment maintenance, 6% for fossil fuel, 1% for tools and equipment and the balance for final

FIGURE 177. PROCESS DIAGRAM OF PROBIO



product packing. Land lease accounts for 20% of production costs, while labor constitutes 17%. Services, which account for 2%, comprise costs such as water, security, mail, etc. Quality control refers to laboratory analyses conducted by external entities and accounts for 2%. Finally, depreciation and administration costs comprise 1% and 12% of production costs, respectively.

ProBio has three key income streams. The main income streams are sales of compost and vermicompost. A minor income is acquired from sale of the nutrient-rich liquid fertilizer from processed leachate. In total, ProBio had revenues of USD 5.7 million in 2013, with a total net income of USD 1 million. The volume of sales for compost and vermicompost is estimated at 231,000 tons per year at a price of USD 30 per ton and USD 70 per ton, respectively. ProBio has been generating profit for several years; indicating that with increased production and demand, aside from incorporation of more innovative-oriented processes, the business stands to attain higher profits and benefits to its shareholders. ProBio restructured its business model in 2014 and made a USD 4.2 million investment in machinery and R&D infrastructure, which will significantly contribute to a cost reduction, particularly in transport and process maneuvers (over 50%) as well as in so far outsourced laboratory analyses (up to 100%).

TABLE 43. BREAK-DOWN OF OPERATIONAL COSTS (2013)

COST ITEM	TOTAL COST (PER ANNUM)
Land lease	USD 1,114,400
Labor	USD 970,700
Operation and maintenance	USD 2,565,500
– Fossil fuel	USD 158,000
– Equipment maintenance	USD 245,000
– Transport and waste collection	USD 1,750,000
– Machinery lease	USD 391,000
– Tools and equipment	USD 15,000
– Product packing	USD 6,500
Quality control	USD 98,000
Depreciation	USD 31,500
Administration costs	USD 798,600
Total	USD 5,578,700

Socio-economic, health and environmental impact

Agricultural operations have become increasingly more intensive to execute economies of production and scale around the world, as pressure to become more efficient continues to grow. This is especially true in livestock operations (swine, dairy cows, etc.), which can generate serious environmental consequences, such as GHG emissions, odor, and water/soil contamination, all a result from improper storage and disposal of animal waste. Confined Animal Feeding Operations (CAFOs) use similar Animal Waste Management System (AWMS) options to store animal residues. These systems emit both methane (CH_4) and nitrous oxide (N_2O) resulting from anaerobic decomposition processes (Clean Development Mechanism, 2007). Additionally, displacement of chemical fertilizers conveys a set of environmental and health benefits that may be achieved by production of organic fertilizers processed from agricultural waste. Businesses that incorporate cleaner waste management solutions such as ProBio have important environmental benefits such as:

- Reduction of CH_4 and CO_2 emissions by avoiding landfill anaerobic conditions;
- Reduction of waste odor, local air and soil pollution by accelerating the decomposition of organic matter present in waste streams;
- Reduction of groundwater contamination and health issues related to nitrogen accumulation derived from chemical fertilizer demand;
- Overall improvement in livestock waste management;
- Overall soil quality improvement from prolonged organic fertilizer application.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Strong relationship and win-win partnership with SuKarne – main input supplier.
- Assured and continuous supply of large quantities of waste – free of charge, aiding economy of scale development.
- Guaranteed high quality product sold at a competitive market price.
- An effective market development strategy.
- Incorporation of efficient and innovative technologies across its operations.
- Increasing chemical fertilizer prices.
- Increasing demand for organic fertilizers due to soil stability issues.
- Fast-growing livestock markets and subsequent insufficient waste management capacity.

There is great potential for ProBio to expand its services to other livestock producers, however land availability for operation set-up close to the waste source may be a constraint. Regarding market share, one of its customer segments, the grain crop sector, is not fully aware and certain of the benefits of organic fertilizers, and considers them an additional cost rather than a long-term sustainable alternative. Further development of this segment will have a significant impact in market access as such crops represent the vast majority of cropland in Mexico. SuKarne's scale in terms of waste generation is probably one of the biggest success factors for ProBio since they are able to provide a constant and high amount of feedstock to the business. This model has a high potential for replication in agrarian countries with large-scale livestock production systems. It is important to note however that the implementation of such a model requires significant start-up capital investment – which is among the most cited barriers for business development in developing countries. In ProBio's case, SuKarne provided key initial financial support as it is obliged to comply with legislative mandates for waste disposal and the implicit cost of non-compliance would be significantly higher – so an incentive for the private sector to invest in such initiatives should exist if similar legislation applies.

Summary assessment – SWOT analysis

Figure 178 provides an overview of the SWOT analysis for ProBio. ProBio is a successful company that reuses the animal waste generated by the beef producer SuKarne to produce compost and vermicompost, and then sells it directly to farmers and households. Essential in its business model is the certification and branding of their organic fertilizer products. This in addition, strategic marketing and sales programs have increased ProBio's market share. Additionally, their agreement with SuKarne has ensured consistent supply of feedstock, mitigating production risk associated with fluctuation in input supply. The establishment of the compost facility in close proximity to the waste source significantly reduces related transportation and labor costs. Technology and related production efficiency, on the other hand, must be improved in order to increase the profit margin, since ProBio takes advantage of economies of scales to generate profit. Opportunities exist for ProBio to fully access the grain crop market segment. This would significantly increase its market share and profit margins due to its important cropland area in Mexico. The latter however requires a bold incentive program for farmers where they would be able to initially try out the product and experience tangible benefits prior to any investment, as uncertainty drives them to consider such fertilizers as an additional cost rather than a strategy to displace high-priced chemical fertilizers. ProBio is willing to bear this risk given its confidence in the quality of its products, as this practice has already proven to be effective. ProBio, however, solely relies on SuKarne to provide livestock waste. Although unlikely given their contractual agreement, in the event that SuKarne would decide to divert its waste supply to another purpose or business, ProBio would face a significant production risk. ProBio is an example of a novel business using a commodity-value approach and a solid partnership with an agro-waste generator to address some of the major waste management and environmental challenges in Mexico whilst generating significant profits and benefits to society.

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FIGURE 178. SWOT ANALYSIS FOR PROBIO

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ Strong business partnership ▪ Low price and high nutrient value of products ▪ Access to cost-free inputs ▪ Creation of image through positive impact on the environment	**WEAKNESSES** ▪ Technology improvement to increase profit margins ▪ Customers not fully aware of benefits of products ▪ Lack of an effective marketing and branding campaign
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Up-scaling of business operations to cater to other large-scale livestock producers ▪ Increasing market share of extensive crop farmer segments ▪ Market expansion to the United States	**THREATS** ▪ Chemical fertilizer market mature and well-established ▪ Waste provider diverting waste for different purposes

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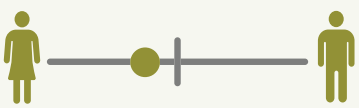
Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2015/2016. As business operations are dynamic data can be subject to change.

BUSINESS MODEL 13

Nutrient recovery from own agro-industrial waste

Miriam Otoo and Munir A. Hanjra

A. Key characteristics

Model name	Nutrient recovery from own agro-industrial waste
Waste stream	Vegetative waste, livestock waste
Value-Added Waste Products	'Regular' compost, enriched vermi-compost
Geography	Regions with significant livestock production, agro-processing enterprises
Scale of production	Medium: 5–40 tons/day; Large: 1,000–2,000 tons/day
Supporting cases in this book	Navaisha, Kenya; Pondicherry, India; Culiacan/Sinaloa, Mexico
Objective of entity	Cost-recovery [ ]; For profit [X]; Social enterprise [ ]
Investment cost range	USD 45,000–USD 2.5 million, depending on scale and technology
Organization type	Private, Public
Socio-economic impact	Cost savings, new revenue and income generation, job creation, reduction of water and land pollution, reduction of CO_2 emissions, averted human health risk
Gender equity	Where biogas is produced in addition to the agro-waste based compost, this can represent increased access to improved fuel options for women 

B. Business value chain

Many agro-industrial entities continue to face the increasing challenge of managing their waste. To ensure business sustainability (typically in compliance to legislative mandates for environmentally friendly waste management practices), agro-industrial entities set up subsidiary businesses to the parent company to convert the agro-waste (tea, horticultural products, sugar mill waste, livestock waste) generated from operations of the latter into an organic fertilizer. The concept is primarily based on the notion that parent agro-businesses generate sufficient business such that its sustainability justifies new capital investments in an onsite nutrient recovery entity to support its own back-end agricultural operations. The concept is simple but the impacts are multi-fold, due to the forward and backward linkages between the parent agribusinesses entity and subsidiaries engaged in nutrient recovery for self-supply to the parent entity but also entry into the larger fertilizer market.

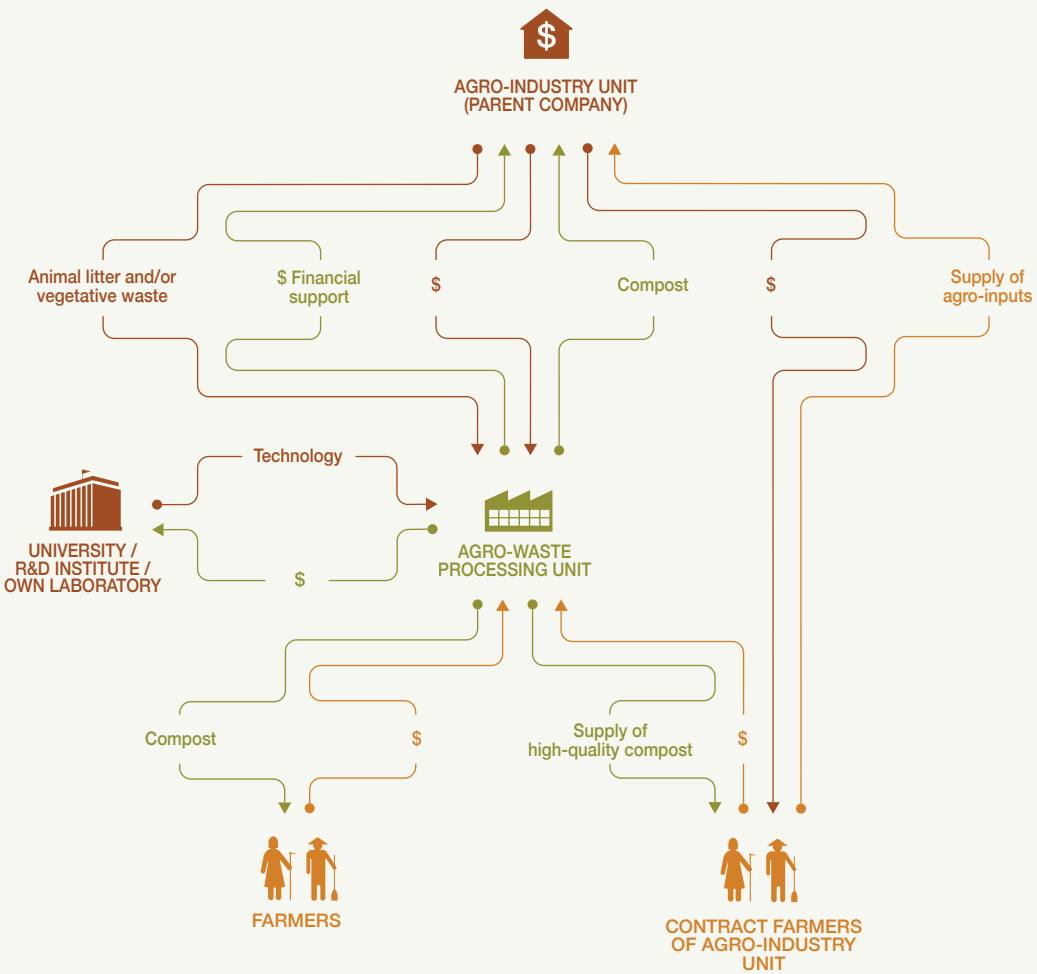
This business model can be initiated by a public, private or public-private partnership entity seeking to address an internal business waste management challenge and additionally generate revenue and diversify their business portfolio. Although this business model is typically geared towards cost-savings, the agro-waste processing entity can generate significant revenue from compost sales

primarily to its parent company (usually if it is an agricultural producer) and local farmers. Investment in innovative technologies (e.g. inclusion of biologically active compounds that promote plant growth and health) can allow them to self-brand their compost product and invariably capture a share of the local fertilizer market. The agro-waste processing unit sources its waste input primarily from the parent company and its affiliates (contract farmers) thus ensuring a consistent supply of resources, oftentimes free of charge or at a lower cost. Quality monitoring activities can be performed by a local university/R&D institute at a fee or their own laboratory. The business concept involves a simple value chain schematic as depicted in Figure 179.

C. Business model

The business model is hinged on two value propositions: a) provision of sustainable waste management (collection and treatment) services and options (nutrient recovery) for 'primary' agro-industrial (parent company) business; and b) provision of affordable, high nutrient organic fertilizer

FIGURE 179. VALUE CHAIN SCHEMATIC – NUTRIENT RECOVERY FROM OWN AGRO-INDUSTRIAL WASTE



for agricultural production (Figure 180). Key success drivers of this business model are based on: a) mutually-beneficial partnership with its parent company – which ensures a consistent supply of waste input (vegetative and livestock waste) free of charge or at low cost and provision of capital investment which mitigates capital start-up risk; b) option of a diversified portfolio through the sale of biological control organisms and different grades of compost tailored to different markets; c) price differential gains from market segmentation for its compost product. Waste input used for compost production is sourced from the parent company. This is a win-win partnership as the latter has a reliable waste management system to ensure sustainability of its business and the former – a reliable source of waste input for production at a fee and start-up capital investment. The business model's main revenue generation streams are from: a) organic fertilizer sales to segmented markets; b) fees received from parent company for waste management.

The business typically sells its compost products primarily to its parent company (if it is an agricultural producer) and directly to local farmers often implementing a segmented-pricing approach with bulk sales to parent company and large-scale farmers at a lower price and a higher price to retailers and smallholder farmers. It is important to note however that depending on the contractual agreement between the parent company and the subsidiary (agro-waste processing) entity, the compost price may be adjusted to account for the cost of collecting and transporting the waste to the waste processing facilities. A competitive marketing strategy such as the provision of free samples of compost to first time users can help build the business' product brand and customer base. Also, by adopting a commodity-value (and using value-addition technologies) the agro-waste processing entity can produce high quality compost tailored to specific clients and agricultural purposes. The success of this approach is dependent on the partnership the business has with key research institutes that can provide support for the development of innovative technologies to produce high-quality products, and also provide product quality analysis services for certification. Third party product certification can help garner significant market demand and mitigate market competition effects from the often subsidized chemical fertilizer. Field demonstrations and semi-commercial tests (farmers, particularly crop farmers are able to initially try the product and observe actual benefits prior to payment) can be instrumental in creating greater market access.

The business can take advantage of economies of scale, depending on the scale of operations of the parent company, and focus on low cost, yet efficient technologies for compost production. Large-scale operations will permit the business to reduce its production costs and charge a lower price of its compost and help capture a larger share of the fertilizer market. The overall investment required for this type of business is relatively modest depending on the scale of operations and investments required at the start-up for R&D (development of innovative technologies), technologies and related equipment. This business model has the potential to generate significant socio-economic and environmental benefits including: job creation and reduced $C0_2$ emissions. Additionally, monetary gains to farmers are represented by increased crop yields and related incomes. This model has a high replication potential especially in developing countries with an increasing number of agro-processing businesses and related limited waste management options.

D. Potential risks and mitigation

The business model presented here was designed and optimized based on the analysis of different case studies (see previous sections). In designing this optimized business model, risks related to safety, local acceptance by the community, and business attractiveness for investors were assessed.

Market risks: The main market risk is related to the business' strong focus and dependence on the launching customer (parent). This can induce the business to lose touch with the market and limit its

FIGURE 180. BUSINESS MODEL CANVAS – NUTRIENT RECOVERY FROM OWN AGRO-INDUSTRIAL WASTE

KEY PARTNERS

- Agro-industrial company (parent company)
- Local university/ R&D institute
- Small scale local livestock farmers

KEY ACTIVITIES

- Waste (vegetative and/or livestock waste) collection
- Production of organic fertilizer
- Brand management, marketing and sales
- Sales and distribution of organic fertilizer

KEY RESOURCES

- Partnership with parent company
- Equipment
- Labor (skilled and unskilled)
- Land and labor
- Vegetative and animal waste
- Partnership with university/R&D institute
- Branding and quality certification
- Contractual agreements

VALUE PROPOSITIONS

- Provision of sustainable waste management options for 'primary' agro-industrial (parent company) business
- Provision of affordable, high nutrient organic fertilizer for agricultural production

CUSTOMER RELATIONSHIPS

- Long-standing business relationship
- Direct sales between parent –sister company
- Personal at direct sales

CHANNELS

- Direct channel with parent company
- Direct sales to local farmers

CUSTOMER SEGMENTS

- Agro-industrial (parent) company
- Small- and large-scale farmers

COST STRUCTURE

- Capital investment (equipment, land, infrastructure)
- Operation and maintenance costs
- Laboratory and product certification costs

REVENUE STREAMS

- Sale of organic fertilizer to segmented markets:
  - Bulk sales to parent company and large-scale farmers (lower price)
  - Sales to smallholder farmers (higher price)
- Fees received from parent company for waste management

SOCIAL & ENVIRONMENTAL COSTS

- Potential contamination of soil and groundwater from disposal of untreated leachate on-farm

SOCIAL & ENVIRONMENTAL BENEFITS

- Job creation
- Reduction in chemical fertilizer use
- Reduction of carbon dioxide emissions
- Improvement in soil structure and nutrient composition
- Reduced nitrate contamination

opportunities for growth. Traditionally, farmers have a high acceptability of agro-waste based compost – especially given its high nutrient content. It is however important to consider quality testing by a third party to minimize market risks associated with consumers' negative perceptions. Whilst this approach can in turn allow the businesses to charge a higher price (from the 'branded' product), it may entail additional costs for which the compost producers have to take in account.

Competition risks: One of the key competition risks to be considered is supportive policies for chemical fertilizer use which may create a non-competitive market environment that negatively affects the sustainability of compost producers. This effect can be mitigated based on the scale of operation and targeted (assured) clientele – bulk purchases from government-owned agricultural department services and the parent firm. Innovative marketing strategies related to free samples and demonstration trials can be adopted to mitigate some of these effects. Resource/input (waste) supply risks are considered to be relatively low due to the assured supply of waste from the parent company.

Technology performance risks: The composting technologies (traditional windrow-composting and vermi-composting) considered under this model are relatively mature and freely available in the market. However, depending on the waste input and technology used, some residual risk may remain. For example, livestock waste-related diseases such as mad cow disease and foot-and-mouth infections need particular attention and quality monitoring and testing programs by a third party should be considered to reduce such risks.

Political and regulatory risks: Policies and regulations related to waste-based compost sectors differ by country. The oftentimes stronger political support for chemical fertilizer use (slow phasing-out of fertilizer subsidies) and lack of specific government guidelines for the certification of compost and internationally accredited third-party certification entities can represent a significant risk to the sustainability of the business model.

Social equity related risks: There are no distinctive social inequity risks anticipated for this business model in terms of poverty and gender. Smallholders could potentially benefit from improved agricultural productivity from increased access to comparatively inexpensive organic fertilizer, if the compost producers choose to sell the excess.

Safety, environmental and health risks: There are potential environmental and health risks that need to be considered under this model. Workers involved in all activities along the compost production value chain (waste collection, separation, compost production, etc.) can be potentially exposed to livestock waste-related diseases if technology performance is not up to par. To safeguard the health of workers, it is imperative that businesses provide and ensure the use of safety gear – hand gloves and rubber boots; conducts an annual medical check up. To address the safety and health risks to workers, standard protection measures are also required as elaborated below (Table 44).

E. Business performance

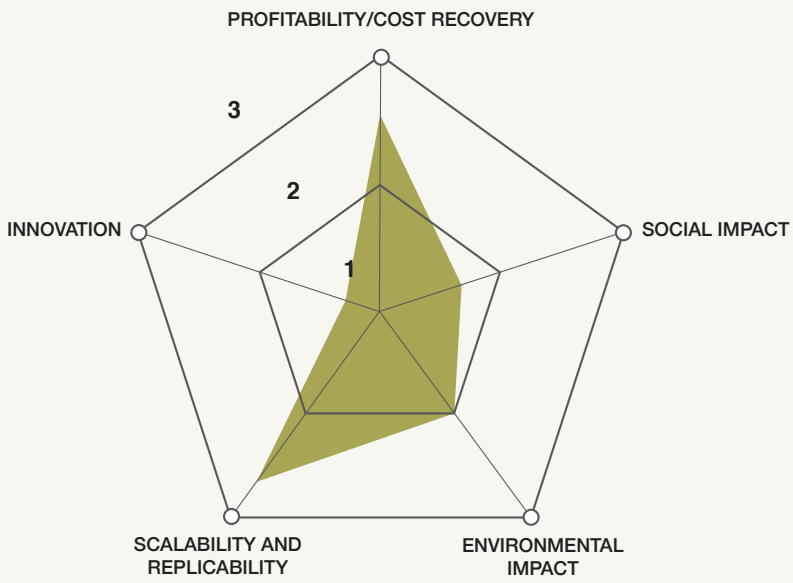
This model ranks high on scalability and replicability due to the increase in agro-industrial businesses and related limited waste management options especially in developing countries (Figure 181). Significant environmental benefits can be realized through nutrient recovery and improved waste management options, as the reduced release of nitrates and GHG emissions results in decreased environmental pollution. This business model however ranks low on social impacts, as aside from employment generation (and oftentimes labor is obtained from the parent company and used internally) and increased access to alternative fertilizers, leaner social benefits accrue to other economic actors along the value chain (e.g. waste collectors, compost retailers). It is noted that most entities either use

TABLE 44. POTENTIAL HEALTH AND ENVIRONMENTAL RISK AND SUGGESTED MITIGATION MEASURES FOR BUSINESS MODEL 13

RISK GROUP	EXPOSURE					REMARKS
	DIRECT CONTACT	AIR/ DUST	INSECTS	WATER/ SOIL	FOOD	
Worker						Potential risk of exposure to e.g. bovine parasites and diseases requires monitoring; Potential risk of dust, noise and chemical compost contaminants
Farmer/user						
Community						
Consumer						
Mitigation Measures						

Key ☐ NOT APPLICABLE ☐ LOW RISK ☐ MEDIUM RISK ☐ HIGH RISK

FIGURE 181. RANKING RESULTS FOR 'NUTRIENT RECOVERY FROM OWN AGRO-INDUSTRIAL WASTE' BUSINESS MODEL



the traditional open-windrow composting technology or vermicomposting or both, to produce regular compost and vermicompost. These technologies are simple, low cost and easily available (technical training) in the market such that the model ranks lowest on innovation. New technologies that help reduce energy costs could improve its rank on the innovation frontier.

11. BUSINESS MODELS ON COMPOST PRODUCTION FOR SUSTAINABLE SANITATION SERVICE DELIVERY

Introduction

Improved access to sanitation is one of the major policy goals throughout developing countries. An emphasis so far has been on the eradication of open defecation, hygiene and improved toilet facilities, ideally connected to sewer systems where urban centres are exploding. Global movements have to date increased access to basic sanitation products which has resulted in a significant percentage of rural and urban populations been connected to household-based latrines and septic tanks (CSE, 2011), however the majority of the population in developing countries still lack access to toilet facilities and substantial efforts are continuously being needed to close this gap. An increasing number of private businesses are setting up public toilet facilities to cater particularly to migratory populations and slum inhabitants who still have marginal access to sanitation products and services, however limited septage collection and treatment can undermine the sustainability of these services.

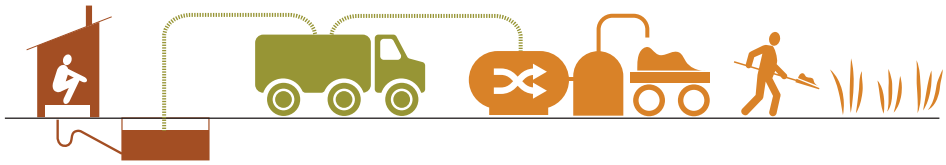
An effective and sustainable sanitation service delivery is one that provides products and services across the entire sanitation value chain, interlinks with the agricultural or other sectors to generate benefits to all economic actors in the respective value chains, and creates connectivity of resources among physical, and biological systems (Figure 182). Resource recovery and reuse of urban septage as peri-urban fertilizer has so far been largely an informal sector activity (Kvarnström et. al., 2012). But with the increasing interest in a green economy, and new technical innovations for fertilizer generation, there is scope for resource recovery to play an increasingly significant role (EAI, 2011). The business model on **sustainable sanitation service delivery** via nutrient recovery from fecal sludge presented here generates the double value proposition of:

- Provision of sanitation systems/ products (such as urine diversion dry toilets (UDDTs)), and reliable waste management (collection and treatment) services to poorer segments of society in greatest need of these services;
- Provision of an affordable, sanitized and nutrient-rich compost product for farmers.

The crux of the business model is hinged on the desirable social impact of providing hygienic sanitary facilities to society, particularly the masses at public places, whilst also providing an effective way to meet agricultural input needs of the farming community via compost production from human excreta. The business approach works because it is built around harnessing economic value from human waste whilst providing sanitation services to the poorer segments of society which represents the greatest percentage of population in need of such services, particularly in developing countries. By re-branding human waste as a needed input instead of a waste output, sanitation/waste reuse-based businesses can create both a physical and financial demand for waste, completely reinventing the economics of sanitation (Murray, Waste Enterprisers, pers. comm., 2014).

In this chapter, we describe a case from **Rwanda** which recognized the opportunities in human waste and is gradually playing an important role in leveraging private capital to help provide sustainable sanitation services and realize commercial the value in waste by shifting the focus from treatment for waste disposal to treatment of waste as a resource for reuse for the ultimate benefit of poor farmers and households (EAI, 2011; Murray and Buckley, 2010).

FIGURE 182. SUSTAINABLE SANITATION VALUE CHAIN WITH RESOURCE RECOVERY



STAGE I
Access to toilet systems, capture and storage of fecal sludge

STAGE II
Collection, storage and transport

STAGE III
Treatment and conversion of fecal sludge into valuable resource for agricultural use

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CASE

Fecal sludge to nutrient-rich compost from public toilets (Rwanda Environment Care, Rwanda)

Andrew Adam-Bradford, Miriam Otoo and Lesley Hope

Supporting case for Business Model 14	
Location:	Kigali, Rwanda
Waste input type:	Source-separated urine and feces from urine diversion dehydrating toilets (UDDT)
Value offer:	Provision of sanitation services and sanitized urine and feces as a safe organic fertilizer for agricultural production
Organization type:	Private
Status of organization:	Operational since 2009 (NGO since 2006); assessed in 2012-2014
Scale of businesses:	Production: 200 tons of fecal-based organic fertilizer per year
Major partners:	Kigali City Council (KCC), United Nations Development Programme (UNDP) and European Union (EU)

Executive summary

Rwanda Environment Care (REC) is a privately owned company engaged in the business of providing public toilet services and producing organic fertilizer from fecal sludge for sale to agricultural producers. With a mismatch between an ever-increasing urban population and the sanitation services provided by the municipalities, a significant number of inhabitants in Kigali have limited to no access to sanitation products such as toilets and when they do, there are virtually no collection systems in place. REC tapped into this gap in the sanitation value chain and has set up several public toilets at different locations in Kigali, Rwanda, using the ecological sanitation (eco-san) technology. The main goal of REC is to implement a sustainable sanitation services delivery system – which ensures that customers not only have access to services (i.e. toilets) but also mechanisms to ensure consistent and efficient waste collection and treatment systems are put in place. Its activities extend to the agricultural sector via the conversion of the collected fecal sludge from their public toilets into a valuable resource – urea-rich organic fertilizer (urine-enriched compost). REC implements a multiple revenue stream strategy comprised of: toilet fees amounting to USD 324 per day, kiosk and shop rentals (USD 334 per month), compost sales (USD 6,483/year) and consultancy service fees from the provision of technical assistance in the design and construction of eco-san latrines. The adopted technology – eco-san toilets – is simple and cost-effective and also ensures easy access to segregated waste inputs. REC's activities provide

inhabitants, especially, the migrating population in Kigali with access to toilets which has significantly reduced the incidence of open defecation and 'flying toilets'. Additionally, reduced open-dumping of human excreta in the environment will reduce the risk of soil and groundwater contamination. Increased availability of environmentally safe fertilizer alternatives will contribute to reducing water and soil pollution from reduced nitrate release attributed to chemical fertilizer use. While the current scale of REC may not have a notable employment impact, with plans to out-scale their activities, it is expected that a significant number of jobs will created along the sanitation value chain.

KEY PERFORMANCE INDICATORS (AS OF 2013/14)						
Land use:	1.6 ha					
Capital investment:	USD 29,173 excluding land costs					
Labor:	2 unskilled full-time laborers					
O&M cost:	USD 188.39 per toilet block of 8 units and 2 kiosks					
Output:	200 tons of organic fertilizer per year					
Potential social and/or enviornmental impact:	Reduced risk of ground- and surface water pollution, reduced health cost associated with poor sanitation, reduced human exposure to untreated waste and chemical pollutants, enhanced soil fertility and productivity, increased food security					
Financial viability indicators:	Payback period:	2 years	Post-tax IRR:	N.A.	Gross margin:	N.A.

Context and background

Rwanda Environment Care (REC) was established in 2005. It received an award of USD 50,000 from a United Nations Development Programme (UNDP) Partnership Small Grant Programme in 2006 to establish fee-paying ecological sanitation services to residents in Kigali alongside rainwater harvesting. In 2007, an additional UNDP grant was awarded which allowed further development of public eco-san latrines in Kigali including the construction of public eco-san toilets in the main districts of Kigali. Rwanda Environment Care (REC) was first established as a pilot project but is now a profit-generating business. In 2009, they introduced a 'sanitation as a business' model which included an improved eco-san design along with additional adjoining units that were rented as kiosks, small shops and/or communication centres. REC's initiatives have been particularly important for Kigali as it has filled an important gap in the sanitation sector as the coverage of sanitation in urban areas is limited, particularly in the low-income areas (slum areas). It is equally important that revenue through fee-charging is generated from such facilities to cover routine repairs and staff salaries ensuring a level of sustainability. In addition to the high demand for public latrines in urban areas, there is an equally high demand for soil conditioners and fertilizer in farming systems throughout the country. Maintaining soil fertility through sustainable land management practices remains a major challenge which is compounded by poor agricultural practices and a lack of access to affordable fertilizers (Donovan et al., 2002).

Market environment

In Kigali, 80% of the population has access to latrines but only 8% of these latrines meet hygienic standards, hence improved access to hygienic and convenient public latrines is an important environmental sanitation and public health measure. Additionally, the significant migration population that characterizes this city makes this an even more important necessity. Furthermore, a continuously available supply of human effluent coupled with farmers' quest for an alternative to chemical fertilizer have been some of the driving forces for the establishment of this business. The maintenance of soil fertility through sustainable land management practices is a major challenge in the agricultural sector of Rwanda, and particularly for peri-urban agriculture in Kigali. REC thus processes fecal matter collected from its eco-san toilet to nutrient-rich organic fertilizer for sustainable agriculture.

Macro-economic environment

Given the relatively high global fertilizer prices, most farmers in Rwanda cannot afford to purchase fertilizers at the beginning of the season. Increasing oil prices and fuel costs have also greatly influenced fertilizer prices in landlocked Rwanda. Hence to make fertilizers more affordable for smallholder farmers, the government introduced the fertilizer subsidy programme for certain food crops. This measure will potentially have an undesirable impact on new businesses like REC who are entering the fertilizer market. They will be facing fierce competition if chemical fertilizer remains comparatively low in price and more cost-effective than organic fertilizers. Comparable incentives will have to be implemented for organic fertilizers to mitigate the effects of competition and facilitate entry of new waste reuse businesses in the fertilizer market.

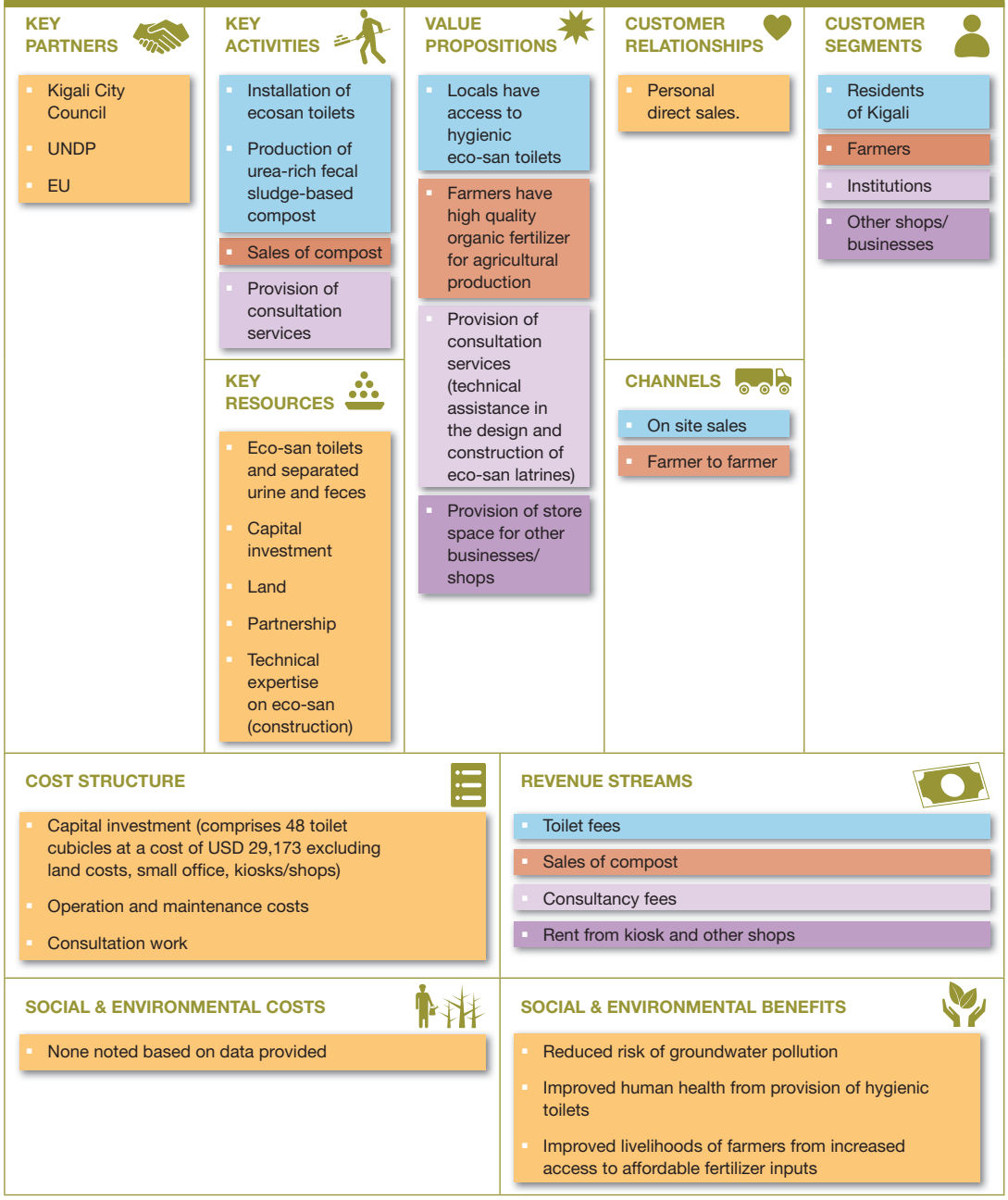
Business model

Figure 183 below presents an overview of REC's business model. REC's business model is based on two main value propositions: a) provision of hygienic eco-san public toilets on a fee-for-use basis; and b) offer of affordable urea-rich, fecal sludge-based organic fertilizer (urine-enriched compost) which is sold directly to farmers. The high demand for public toilets in Kigali ensures a daily revenue through toilet fees. On average, the 4,000 daily users generate a total of 200,000 Rwandan Francs (RWF) (USD 324 per day). An essential part of this enterprise is the inclusion of other shops in the toilet complex, from which rent is derived, increasing the revenue stream available to the enterprise. In addition to the provision of public latrines, REC plans to provide an eco-san consultancy service through the provision of technical assistance in the design and construction of eco-san latrines which will include follow-up visits in the first six months of operation. An example of this consultancy work has included constructing eco-san toilets in over 18 schools over the last five years which were funded through the American NGO Water for People. The multiple revenue stream strategy ensures and secures funds for the composting component of the business and safeguards it from shocks such as delayed payments. REC received financial support from UNDP and the EU and land free of charge from the Kigali City Council. These grants were crucial at the start-up phase of the business given how traditionally difficult it is to access funds from formal financial institutions. REC's activities have resulted in several socio-economic and environmental benefits. Increased access to toilets especially in low-income areas have significantly reduced the incidence of open-defecation and 'flying toilets' and consequently environmental pollution. Increased access to environmentally safe and affordable fertilizer alternatives represent monetary gains for small-holder and large-scale farmers.

Value chain and position

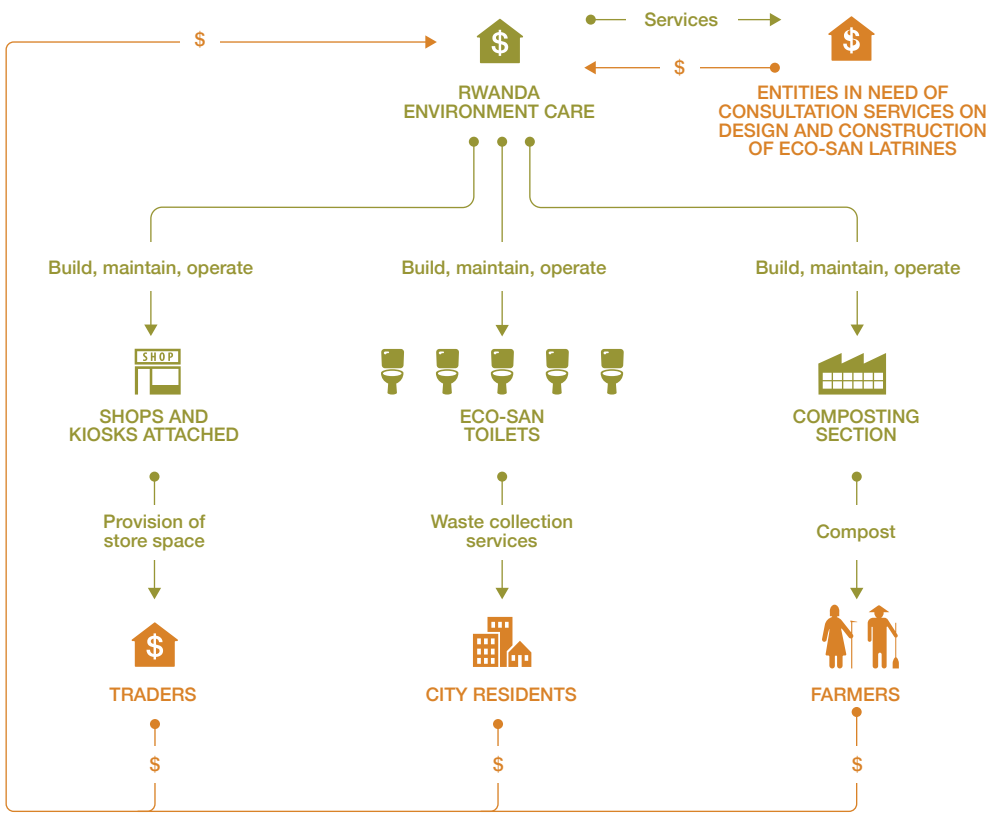
Figure 184 provides an overview of REC's value chain. REC's business is composed of four main parts: a) provision of toilet facilities on a fee-per-use basis; b) provision of shops and kiosks to traders; c) sale of fecal sludge-based organic fertilizer to farmers; and d) provision of consultation services on technical assistance in the design and construction of eco-san latrines. From its early years, REC has constructed and managed five eco-san units in Kigali at the following locations: Kigali City Council (12-door toilet facility); Nyabugogo (12-door toilet facility); Kacyilry (four-door toilet facility); Kimironko (12-door toilet facility); and Kicukiro (eight-door toilet facility). The resulting 48 toilets in the city which on average receive 4,000 users on a daily basis are producing an estimated average of 0.6 tons of fecal matter per day. The high demand for public toilet use ensures a consistent waste supply stream. Quality factors such as moisture (i.e. eater use) can be regulated and monitored, ensuring high quality of the waste input. Currently there is no competition in this supply stream as new eco-san toilets are located where public toilets facilities are limited. The enterprise uses human effluents obtained from its toilet business and processes it into fertilizer, hence faces no competition for the waste input. The urine (urea)-enriched organic fertilizer is sold directly to large-scale farmers in the Northern Province who come to the site for purchase. Prior to collection the compost is stored at a central site in Kigali

FIGURE 183. REC'S BUSINESS MODEL CANVAS



where it undergoes final decomposition before being bagged and stored ready for collection. During the assessment period, REC produced annually over 200 metric tons of compost generating over RWF 4 million, which in 2012/13 corresponded with about USD 6,483. The compost is bagged and stored at a centralized yard in Kigali ready for collection. Demand was from the start higher than production and this has remained constant. REC does recognize that the government subsidized chemical fertilizer

FIGURE 184. RWANDA ENVIRONMENT CARE'S VALUE CHAIN



programme could represent competition for their compost product and thus the need to implement a long-term marketing strategy to increase its share of the market. Additional revenue streams such as renting out shops and kiosks incorporated in the toilet building design has been important for REC in mitigating fluctuations in compost demand, thus invariably improving the sustainability of the business.

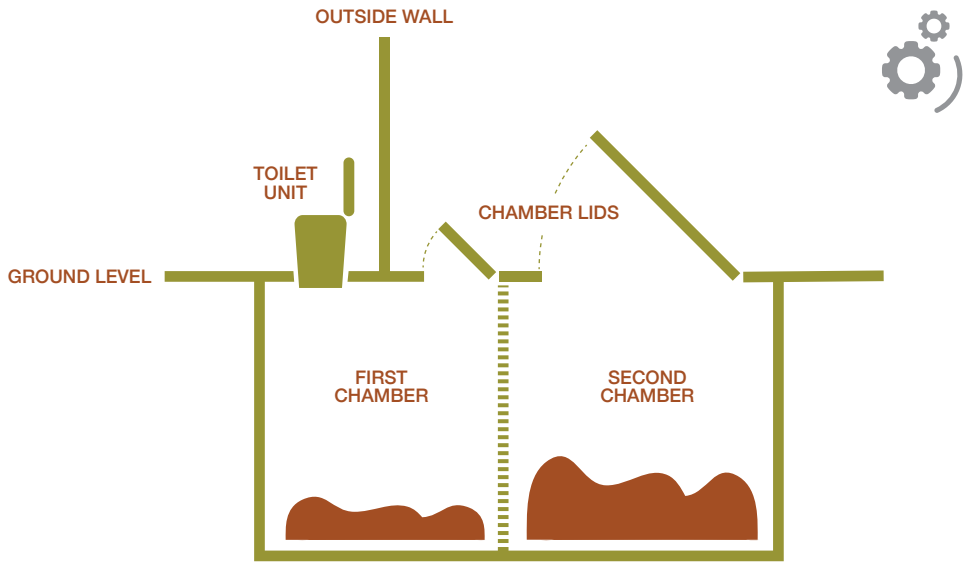
Institutional environment

Eco-san toilets were a relevant new introduction in Rwanda and while there are laws and regulations on the use of human waste issued by the Rwanda Utility Regulation Agency these did not have specific quality standards or guidelines for ecological sanitation. Consequently, REC has been working with the government agency to draft appropriate eco-san quality standards and guidelines. The Rwandan government is supportive of eco-san interventions as illustrated in the fact that urban land is provided by local authorities for projects such as eco-san toilets as they recognize this as an important contribution to service provision in urban environmental sanitation.

Technology and processes

Eco-san toilets are based on a very pragmatic principle of on-site treatment while separating the liquid and solid elements of human waste (Figure 185). In doing so, it brings several advantages such as

FIGURE 185. ECO-SAN CHAMBER DESIGN AS USED BY REC



Note: Urine diversion not shown and chambers not drawn to scale

removing the necessity for having flushing water in a toilet system, thus eliminating any wastewater that would normally flow into a septic tank or sewer. Also diverting urine from fecal matter and then keeping the fecal matter relatively dry eliminates the strong odors associated with the combination of urine and fecal sludge. Once urine is isolated and stored in a container the odor is reduced, moreover with usually no bacterial contamination the urine can be added to the latter stages of composting for compost enrichment or be diluted with water and instantly applied as a crop fertilizer. The fecal matter takes considerably more time to decompose into a state ready for crop application, consequently in the design of all eco-san toilets the separation of liquid and solid waste is a central feature. For the liquid element, urine is normally channelled into a receptor thus providing a safe method of harvesting and storing the urine, but in regards to managing the solid matter there is a degree of variation in how the solid element of human waste is collected, stored and treated, for example variations in chamber size, the use of chambers in series or in standard parallel arrangement and addition of solar heated chambers. The eco-san toilet systems have been designed in such a way that the physical structure fits the surrounding environment. One or two chamber systems can be used. In the latter, the smaller chamber is directly under the toilet unit while the adjoining larger chamber allows entry for a worker to shovel the dry waste from the first chamber to the second, and to empty the compost once it has matured. To increase heat in the large chamber and provide optimum decomposition conditions, the metal lid of the chamber is painted black to absorb solar radiation. Due to high number of users, the pits get full within a short time. Ideally, once the pits get full, the toilets are decommissioned for a period of at least three months during which the feces are left to compost. However, as the toilets are needed, the fecal matter is transferred to an external dry place to complete the composting which allows the vaults to be used again.

Funding and financial outlook

The project was funded by the UNDP and EU at an initial cost of USD 29,173 for the construction of an eight-door toilet complex with two kiosks. This amount is exclusive of land costs which was provided

for free by the urban council. It is estimated that initial construction investment can be recovered in a two-year period. Operation and maintenance costs for a block unit is projected at USD 84 per day. REC has currently three revenue streams: toilet fees, kiosk/shop rentals and compost sales. On average 4,000 daily users of eco-san toilet generate USD 324 per day and the sale of 2,000 bags of compost generates USD 6,343 annually. Toilets fees anchor the compost business as noted from the significant difference in the revenues generated.

Socio-economic, health and environmental impact

REC's initiatives provide eco-san toilets of hygienic standards to the Kigali community and has reduced the intense pressure which hitherto existed on the available public toilets. It employed at the time of the study two people who work on a full time basis and are responsible for the collection of toilet fees as well as daily cleaning and maintenance of the facility. REC ensures to mitigate occupational health risks by providing protective gear (i.e. masks and gloves), which the staff are obliged to wear while working on site and particularly during chamber emptying operations. REC also ensures that it produces a safe compost product which is achieved from the long storage period of the decomposed substrate in the eco-san systems before collection. This ensures that most pathogens are eliminated before the product is used for any agricultural production. In the early phase of the project, microbial levels were tested and found to meet an acceptable level but it was noted that such testing has not become a routine measure and the results of the initial testing were not available. This however does not discount the significant quantities of nutrients recovered from the human effluent which is used for farming activities, thus improving the nutrient level of soils and increasing productivity.

Scalability and replicability considerations

The key drivers for the success of this business are:

- Significant migrating population that are in need of convenient public latrines.
- Strategic partnerships to mitigate capital investment risk at start-up phase; technology and product development/innovation.
- Assured supply of key production input (human excreta) at no cost.
- Increasing farmers' quest for a more affordable alternative to chemical fertilizer.
- Multiple revenue streams – which mitigates risk associated with fluctuations in demand of any of their products and services.

REC's model is replicable and can be scaled out and up especially in communities with no access to the flush toilet system. However, the replication and scaling up and out of this model is highly capital intensive. In Rwanda, eco-san toilets have proven to be successful and socially acceptable, however the main constraint in replicating such services is access to investment funds although the work of REC is now being recognized and the sector is attracting the interest of local development banks.

Summary assessment – SWOT analysis

Figure 186 presents an overview of the SWOT analysis for REC. By implementing a multiple revenue stream strategy, REC is able to safeguard the business from shocks such as delayed payment for compost or seasonal demand, or decreased demand in the provision of any of its products and services. This business has been particularly successful in leveraging its business partnerships to mitigate capital investment risk. Also importantly, it uses a technology that has a key advantage, i.e. there is no wastewater or sludge produced as in a flush-based toilet systems or pit latrines. The technology can be raised off the ground and is thus compatible with flood prone areas or in locations with high water tables as the risk of groundwater contamination is avoided. Currently, the use of urine-based fertilizers remains an underexploited resource in farming systems around Kigali, so demand

FIGURE 186. SWOT ANALYSIS FOR RWANDA ENVIRONMENT CARE

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ Diversified revenue streams ▪ Easy accessibility and availability of waste input ▪ No wastewater or sludge is produced from process ▪ Suitable in flood prone areas ▪ Compost is rich in urea ▪ Strong partnership with the municipality ▪ Latrines meet hygienic standards	**WEAKNESSES** ▪ Inadequate market strategy ▪ Capital intensive at start-up phase ▪ Site location may increase distribution cost ▪ Technology requires expertise ▪ Limited storage capacity ▪ Under high usage, composting periods within the pit gets shorter
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Increase in toilet users ▪ Increase in compost users ▪ Sale of urine-based organic fertilizers	**THREATS** ▪ Competition from continued subsidization of chemical fertilizers ▪ Some cultural values prevent usage of public toilets ▪ Regular monitoring necessary to ensure correct usage and effectiveness of composting

remains low mainly due to a lack of awareness in its benefits as a liquid fertilizer. As REC does not have the capacity to store and transport urine for on farm applications they have found an alternative use for the resource, which consists of using the urine to enrich the compost by adding quantities of urine to the compost heap during the later stages of decomposition. This is a common practice found in small-scale gardening as the urea feeds the bacterial action in the composting process. There is a great opportunity for REC to add value to the collected urine and with a sound marketing strategy increase its share of the fertilizer market. The compost from human excreta is sold directly to farmers and plans are underway to develop a market for the enriched urine. Although operating so far on a small-scale, the scaling-up and out of REC's initiatives supported by its partners, like SNV, has a high potential to generate significant impact.

Contributors

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Valentin Mucyomwiza, Rwanda Environment Care (REC)

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Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2012/14. As business operations are dynamic data can be subject to change.

BUSINESS MODEL 14

Compost production for sustainable sanitation service delivery

Miriam Otoo and Munir A. Hanjra

A. Key characteristics

Model name	Compost production for sustainable sanitation service delivery
Waste stream	Source-separated urine, feces from urine diversion dry toilets (UDDT) and pit/septic tanks
Value-added waste product	Urine-based fertilizer and fecal sludge-based soil conditioner
Geography	Suitable for slum areas/communities with limited provision of waste management service and/or no access to the flush toilet system. UDDT technology particularly suitable for flood prone areas or in locations with high water tables
Scale of production	Small to medium: 150–200 tons of fecal-based organic fertilizer
Supporting case in this book	Kigali, Rwanda
Objective of entity	Cost-recovery [ ]; For profit [X]; Social enterprise [ ]
Investment cost range	USD 25,000–32,000
Organization type	Private or business foundation
Socio-economic impact	Improved access to sanitation facilities, reduced health cost associated with poor sanitation, reduced human exposure to open waste dumping, enhanced soil fertility and agricultural productivity, jobs for unemployed
Gender equity	Toilet provision. Reduced practice of open defecation away from home, especially in the dark, reduces personal risk for women and girls 

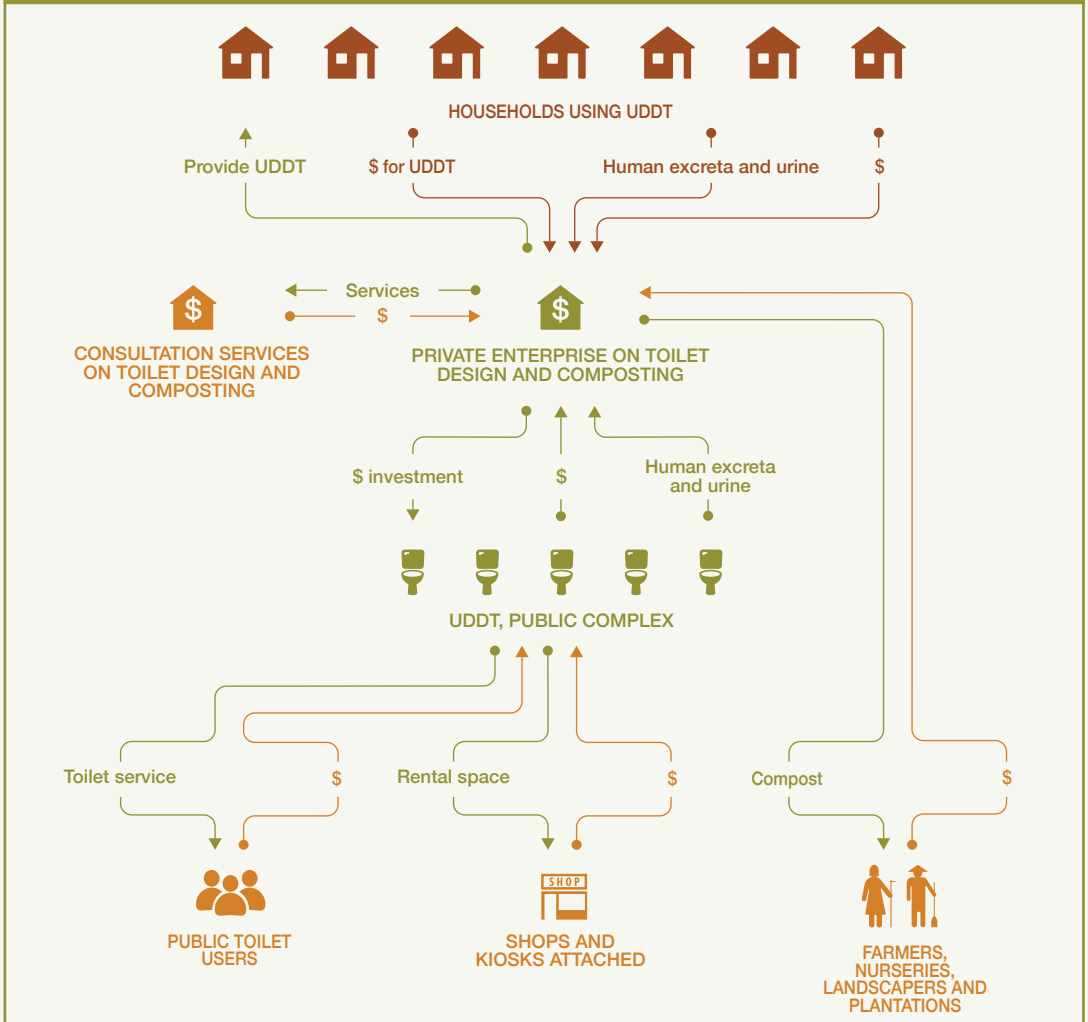
B. Business value chain

Many cities and towns across Africa and Asia have a huge gap in sanitation services and waste management – and are far below required international coverage standards. Open defecation continues to be a common practice in view of limited access to basic sanitation products such as toilets facilities suited to the local environment. Additionally, limited public funds to support waste management infrastructure and services has resulted in significant environmental pollution as the majority of the generated waste (e.g. human excreta), whether collected or uncollected is often disposed of untreated in unofficial and open spaces, water bodies and/or landfills (Kinobe et al., 2015). This situation is particularly exacerbated for large urban areas characterized by a growing population and rapid migration.

The business model – sustainable sanitation service delivery system – can be initiated by a private entity or a business-oriented foundation seeking to fill the gap in sanitation service delivery value

chain by providing products and services particularly to poorer segments of society (e.g. slums) in greatest need of these services, and also converts collected fecal sludge from households and public toilets into a valuable resource: organic fertilizer for agricultural use (Rao et al., 2016). In the primary market, the business entity provides sanitation products (toilets) and services (i.e. public toilets, waste collection services) to two main customer segments: households and public masses at a fee (Figure 187). The value for customers in the primary market is increased access to toilet facilities, and reliable and clean removal of fecal sludge. In the secondary market, the collected septage is converted into a nutrient-rich organic fertilizer and is sold to peri-urban farmers. In the secondary market, increased availability of environmentally safe fertilizer alternatives will contribute to reducing water and soil pollution from reduced nitrate release attributed to chemical fertilizer, and also represent significant savings for farmers.

FIGURE 187. VALUE CHAIN SCHEMATIC – COMPOST PRODUCTION FOR SUSTAINABLE SANITATION SERVICE DELIVERY



A unique feature of this model is its viability potential which is driven by a multi-revenue stream and hinged on its primary market. The business generates the majority of its revenues from the sale of toilet facilities, provision of public toilets and waste collection services. It is able to generate sufficient funds to additionally cover the compost production costs, if needed. This is crucial as the sustainability of the primary market largely depends on the business been able to reuse or dispose of the human excreta safely.

C. Business model

The business model is hinged on three value propositions: a) supply and maintenance of ecological sanitation systems (such as urine diversion dry toilets (UDDTs)); b) provision of reliable waste management (collection and treatment) services to poorer segments of society in greatest need of these services; c) provision of affordable and high quality organic fertilizer for agricultural production. This translates into a multiple revenue stream strategy comprised of: sale of eco-san toilets, toilet user fees, kiosk and shop rentals, compost sales and consultancy service fees from the provision of and technical assistance in the maintenance of eco-san toilets and latrines, which ensures sustainability in business operations. This reflects the important success driver for the model which is the diversification of its portfolio which cuts across the entire sanitation value chain in the provision of toilets, waste collection services and organic fertilizers. Additionally, this business model adopts a service oriented approach in which it uses revenue generated from the provision of toilet facilities to run the composting section, which safeguards the business from shocks such as delayed payment for compost or seasonal demand, which could otherwise halt the smooth running of operations and affect the sustainability of the business.

The overall investment required for this type of business is relatively modest depending on the scale of operations, with major investments required at the start-up for the purchasing of toilet facilities and construction of the public toilets. Strategic partnerships with local government, municipalities, city councils, agriculture department and international financiers are instrumental not only for the purposes of gaining access to start-up financing but also customer segments for their compost product. The business model described in this chapter presumes the operation for a standalone private enterprise (Figure 188), and could also be useful for festivals and music events.

D. Alternate scenarios

Scenario I: Franchise model for safe and sustainable sanitation service delivery

An alternative to the generic business model of sustainable service delivery is the inclusion of a franchising system (Figure 189). It is assumed that at this scaling-up stage of the business, the private entity has sufficient private equity or collateral to obtain financing in order to set up the franchise system. The private/business entity (franchiser) creates a network of entrepreneur managed toilets and composting units. The network is organized within the framework of a franchise. The franchiser supplies the toilet and composting units on demand to its franchise partner network across several cities. The use of the franchiser's name brand and access to their business strategy comes at a cost to the franchisee. The franchisees deliver their composted material to the nearest franchise collection point which the franchise purchases. The franchisees have a sustainable system where they are able to earn revenue from toilet user fees and sale of composted materials without worrying about having a market for their product. The franchiser has the opportunity to sell to bulk buyers such as commercial farmers and large-scale organic food producers, given their increased scale of production. They are able to monitor the quality of the compost via their own product testing and occasional checks. Whilst the franchisor's success depends on the success of the franchisees, the franchisee has a greater incentive than the direct employee because they have a direct stake in the business. There is a risk

FIGURE 188. BUSINESS MODEL CANVAS – COMPOST PRODUCTION FOR SUSTAINABLE SANITATION SERVICE DELIVERY

KEY PARTNERS

- City Council
- International development partners
- Financiers

KEY ACTIVITIES

- Supply and maintenance of ecological sanitation toilets
- Waste collection services
- Production of fecal sludge-based fertilizer
- Sale and marketing of compost product
- Provision of consultation services

KEY RESOURCES

- Eco-san toilets and human excreta
- Capital investment
- Land
- Partnership
- Equipment (protective gear, desludging machinery)

VALUE PROPOSITIONS

- Urban population have increased access to toilet facilities
- Reliable provision of waste collection services
- Provision of high quality and affordable fertilizer alternative
- Provision of rental space to other businesses

CUSTOMER RELATIONSHIPS

- Personal and direct sale

CHANNELS

- Direct sales of products and services to households, institutions and farmers

CUSTOMER SEGMENTS

- Urban population (households, institutions)
- Commercial and medium-scale farmers, organic farmers (especially flower industry)
- Other small-scale businesses

COST STRUCTURE

- Capital investment (comprises small office, public toilets, kiosks/shops)
- Operation and maintenance costs

REVENUE STREAMS

- Sale of eco-san toilets
- Toilet user fees
- Sales of compost
- Rent from kiosk and other shops

SOCIAL & ENVIRONMENTAL COSTS

- Possible human health risk from handling of excreta if appropriate protective gear is not utilized

SOCIAL & ENVIRONMENTAL BENEFITS

- Reduced risk of water pollution and nitrate leaching
- Improved human health from increased access to hygienic toilets
- Improved yield due to application of affordable and nutrient-rich organic fertilizer
- Reduced incidence of open defecation
- Reduced open dumping of human excreta
- Increased access to toilets in low-income areas/slums

for the people that are buying the franchises as failure rates are noted to be higher for franchise businesses than independent business start-ups. Factors related to fair pricing of equipment and supplies from the franchisor, fees for training and advisory services charged by the franchisor, royalty fees, amongst others can influence the sustainability of the franchises. Overall, the franchising model has great potential to generate significant benefits to multiple economic actors in both the sanitation and agricultural value chains as it provides not only an opportunity for the franchiser to increase its profits but it also represents increased access to toilet facilities and waste management services for a greater number of households and improved fertilizer options for agricultural producers.

FIGURE 189. BUSINESS MODEL CANVAS – FRANCHISE MODEL FOR COMPOST PRODUCTION AND SUSTAINABLE SANITATION SERVICE DELIVERY

KEY PARTNERS

- National Agricultural Research
- City Council
- International development partners
- Financiers

KEY ACTIVITIES

- Setting-up the franchises for sale and distribution of sanitation products
- Supply of UDDTs to households
- Collection of human excreta from households and public toilets
- Production of urine and fecal sludge based fertilizer
- Marketing and sale of organic fertilizers

KEY RESOURCES

- Financing
- Equipment (UDDTs, storage tanks)
- Human excreta
- Labor, land
- Partnerships
- Quality control
- Standards and certification

VALUE PROPOSITIONS

- Provision of business opportunities to unemployed
- Urban population have increased access to toilet facilities
- Reliable provision of waste collection services
- Provision of high quality and affordable fertilizer alternative
- Provision of rental space to other businesses

CUSTOMER RELATIONSHIPS

- Direct contact with businesses (franchisees)
- Direct contact with households institutions and farmers

CHANNELS

- Franchise sale points
- Direct sales of products and services to households, institutions and farmers

CUSTOMER SEGMENTS

- Franchisees (business owners)
- Public toilets, households, institutions
- Commercial and medium scale farmers, organic farmers (especially flower industry)

COST STRUCTURE

- Capital investment
- Labor
- Equipment
- Laboratory costs
- Quality assurance and monitoring

REVENUE STREAMS

- Sale of UDDTs to households and through franchise
- Charges for public toilet unit visit
- Waste collection fees
- Sale of urine-based liquid fertilizer (limited but potential)
- Sale of fecal sludge-based fertilizer

SOCIAL & ENVIRONMENTAL COSTS

- Possible human health risk from handling of excreta if appropriate protective gear is not utilized

SOCIAL & ENVIRONMENTAL BENEFITS

- Increased access to toilets in low-income areas/slums
- Improved human health from reduced open dumping of human excreta
- Improved yield due to application of affordable and nutrient-rich organic fertilizer
- Reduced risk of water pollution and nitrate leaching
- Enhanced soil fertility and productivity
- Employment generation
- Greater number of beneficiaries from up-scaling and uptake through franchise model

E. Potential risks and mitigation

The business model presented here was designed and optmized based on the analysis of different case studies and literature review. In designing this optimized business model the risks such as safety, local acceptance by the community and business attractiveness for investors were addressed.

Market risks: There is a huge imbalance between the demand and supply of sanitation products and services especially in fast growing cities in developing countries, such that open defecation and open dumping signals huge market potential but in some settings the affordability comes into question due to the very low income and socio-economic status of the communities. Households' low-ability to pay for sanitation products and services may pose a market risk for this model. This model has proven some initial success and social acceptability despite the stigma associated with waste-based fertilizers. Farmers' low willingness to pay for the compost in view of chemical fertilizer alternatives poses a risk to the sustainability of the model. This risk can however be mitigated from revenue generated from other streams. Additionally, storage and transportation challenges of the liquid-based urine fertilizer may also require an agricultural community nearby for reuse.

Competition risks: Competition risk could come from other suppliers of comparable sanitation products and services, more evidently from the chemical fertilizer sector. Policies and programs such as fertilizer subsidy programs make chemical fertilizer prices relatively lower than compost prices, and thus more cost-effective for farmers. Comparable incentives are needed to mitigate these effects for waste-based organic fertilzer businesses.

Technology performance risks: There are minimal to no technical performance risks associated with the composting technology. Whilst the technology is quite new in most developing country settings, it is relatively simple to implement. The sustainable sanitation technology design separates urine and

keeps the fecal matter dry to elimate strong odor. Dry fecal matter can be processed into compost and directly used as fertilizer. After storage the separated urine can be directly used as liquid fertilizer in dilution with water, and after storage for two to six months for unrestricted application. The compost production is also low cost and flexible in terms of scale and has relatively simple quality assurance procedures and does not require a high-level of technical expertise.

Political and regulatory risks: National regulations on the reuse of human excreta for agricultural purposes differ, and this determines the scope within which sanitation businesses can engage in resource recovery. Even in cases, where reuse is permitted, the lack of regulations and standards on products and associated certification and quality minitoring pose significant risks for businesses. The provision of ecological sanitation facilities in cities is generally well-received by the governmental entities, in many developing countries.

Social equity related risks: This business model does not have any known social inequity risks. On the other hand, it significantly increases access to sanitation products and services, especially for migratory populations and slum inhabitants. From an agricultural perspective, farmers have improved livelihoods given their increased access to high nutrient organic fertilizers which contributes to improved agricultural productivity.

Safety, environmental and health risks: Also where UDDTs are used, potential pathogenic health risks to different actors along both the sanitation and agricutural value chains remain, associated with the collection, treatment, processing and use of human excreta (Table 45). In particular, workers that collect the (largely dried) fecal sludge and composted materials are at risk. The provision of protective gear for chamber empyting operations should be mandatory. For the compost buyer, microbial standards can provide trust, while from the food consumer perspective, careful washing and boiling should be a routine measure. Additionally, farmers must be trained on the appropriate application methods for the waste-based fertilizer products. Recommendations of national agriculture agencies must also be implemented in tandem, in association with agricultural extension agents.

TABLE 45. POTENTIAL HEALTH AND ENVIRONMENTAL RISK AND SUGGESTED MITIGATION MEASURES FOR BUSINESS MODEL 14

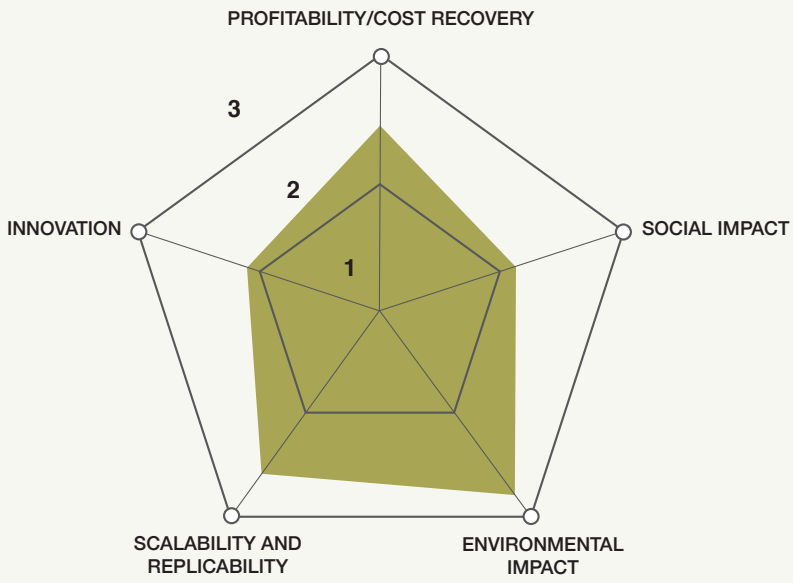
RISK GROUP	EXPOSURE					REMARKS
	DIRECT CONTACT	AIR/DUST	INSECTS	WATER/ SOIL	FOOD	
Worker						Potential health risks to different actors along both the sanitation and agricutural value chains are associated with the collection, treatment, and processing of human excreta
Farmer/user						
Community						
Consumer						
Mitigation measures						

Key: NOT APPLICABLE; LOW RISK; MEDIUM RISK; HIGH RISK

F. Business performance

This model can be scaled up and decentralized through franchise operations across cities in Africa and Asia. A greater opportunity for scaling up and out the sanitation products (UDDTs) and services (waste collection, composting) exist particularly for slum areas due to limited provision of sanitation services. This model ranks highest on environmental impacts due to its catalytic role in protecting human and environmental health by reducing open defecation and unsafe disposal of human excreta. The model ranks second on scalability and can be replicated extensively in cities and neighbourhoods lacking toilet facilities (Figure 190). The model ranks next highest on profitability, because the model generates several revenue streams including toilet visit fees, sale of urine-based liquid fertilizer, sale of compost, fees for waste collection services and rental from shops in the toilet complex and even consultancy services where applicable. For the generic business model, the technology involved is simple, low cost and easy to use, and hence innovation rank is the lowest.

FIGURE 190. RANKING RESULTS ON COMPOSTING MODEL FOR SUSTAINABLE SANITATION SERVICE DELIVERY



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12. BUSINESS MODELS FOR OUTSOURCING FECAL SLUDGE TREATMENT TO THE FARM

Introduction

With a limited number of septage treatment systems in many parts of the developing world, business entities that empty latrines or cesspits often discharge the sludge onto open lands, in landfills or into wetlands, instead of driving to remote official dumping sites. There is an urgent need to address this challenge through more fecal sludge treatment plants. Where this is not possible also farm based systems can offer safe treatment while directly recovering nutrients from fecal sludge for agricultural production.

Fecal sludge is an abundant and valuable resource as the dominating urban sanitation system in both South Asia and Sub-Saharan Africa are septic tanks and latrines (Chowdry and Koné, 2012; Dodane et al., 2012). Its low chemical and metal contamination in household based on-site treatment facilities makes the collected fecal sludge (septage) a valuable soil ameliorant similar to other organic manure such as farmyard manure with high application potential in farming and landscaping (Otoo et al., 2015). The reuse opportunity that lies in the fecal sludge waste stream is especially important where soils are poor and the availability of alternative inputs is expensive. In particular, in areas where affordable fertilizer production or its access is limited, smallholder farmers might use the fecal sludge for fodder, tree (crop) plantation or cereal production. Farmers in West Africa and South India, for example, re-direct cesspit truck operators to their fields to obtain the nutrient rich manure (Drechsel et al., 2011; Evans et al., 2013; Kvarnström et al., 2012). In Northern Ghana, this typically occurs after cereal harvest in the dry season (Cofie et al., 2009). Due to the aridity and heat, the sludge dries over several months and is then incorporated into the soil.

The observed reuse business model between farmers and truck operators reverses the cash flow, as farmers pay the drivers for farm-gate delivery, while otherwise the transporter must pay a tipping fee for desludging into a treatment pond. In an optimized business model, the revenue would ideally support the operation and maintenance costs of the cesspit operation, supplementing the fecal sludge household collection fee. However, an economic drawback to the sustainability of the system is the seasonality in demand for fertilizer, which are often only applied once or twice over the cropping cycle. Fecal sludge is applied as a basal fertilizer at the start of the dry season, allowing it sufficient time to dry over several months before it is incorporated into the soil, and cereals are planted. Sludge marketability is different with (tree) plantation crops, like in India, which can benefit from fecal sludge throughout the year. However, where farmers do not have spare land for the fecal sludge to be initially stored, the voluminous characteristic of the raw fecal sludge can become a constraint. This bottleneck has been bypassed in parts of Karnataka where sludge is collected and sun-dried by larger enterprises, for auctioning to farmers.

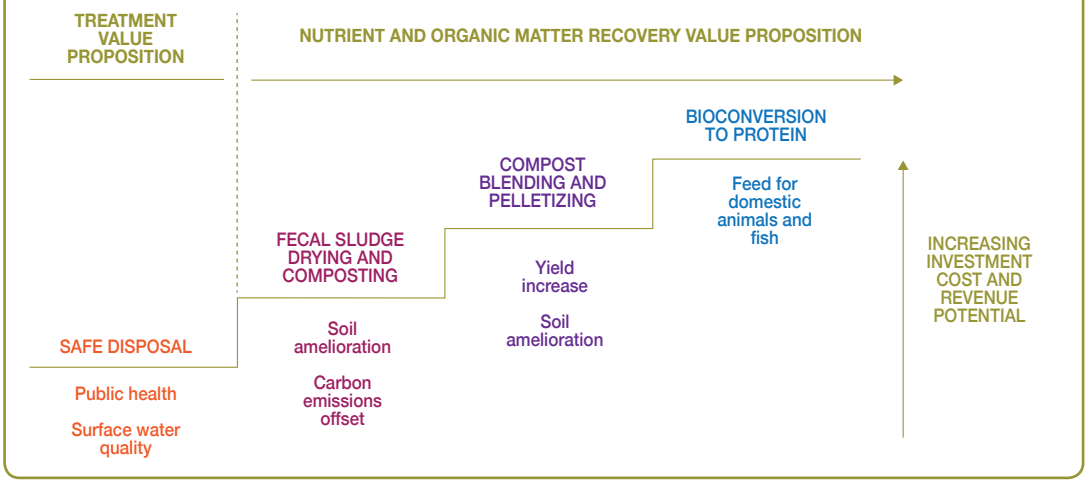
In most developing countries, fecal sludge as a source of fertilizer has not received much recognition, due to both the informal nature of reuse and possible cultural or perception barriers. Moreover, the disposal of fecal sludge onto land, particularly agricultural land, is often prohibited by law – or is, at least, a grey area governed by ‘tacit approval’. In other words, ‘culprits’ have not been punished, especially where engineered, official dumping places are still an exception and the authorities are left with little choice. Where official dumping sites exist, cesspit truck owners pay to use them. Health concerns by authorities concerning the use of raw fecal matter in food production limit the extent of this activity, although with sufficient solar drying as observed in Ghana, and crop restrictions, the risks can be minimized (Seidu, 2010; Keraita et al., 2014), even where no other regulations govern the process. Most pathogens die during sun exposure, so health risks for consumers of cereals grown on this land are minimized (Seidu, 2010). To mitigate also health risks for farmers, they are required to use protective gear.

Other controlled resource recovery approaches can further reduce the potential health and environmental risks associated with fecal sludge use, and increase farmers' accessibility and usability. These steps and trajectories of increasing value proposition have been realized in different regions and are illustrated as shown in Figure 191. An observed pathway of value proposition for agricultural reuse is:

1) Direct land application of the raw fecal sludge for agricultural purposes – where value addition occurs in the form of sludge collection and transportation to the farm or plantation, usually followed by natural solar-treatment (sun drying) or incorporation in the soil as an alternative treatment and risk reducing option (Keraita et al., 2014).
2) To limit the risks for farmers, the fecal sludge can also be dumped on designated unplanted drying beds followed by composting (or co-composting with other organic waste to improve the carbon–nitrogen ratio) before sale. The value addition lies in removing pathogens, reducing the volume and concentrating the nutrients. Moreover, co-composting is an approved Clean Development Mechanism (CDM) activity. The bulky nature of composted fecal sludge can however act as a barrier to the transportation of the product to markets, increasing the distribution costs, which are borne by the end-users.
3) To increase the accessibility and usability of the composted product, pelletization and blending of fecal sludge-based compost with rock-phosphate, urea/struvite or any industrial fertilizer will allow the product to have nutrient levels specific for target crops and soils, and a product structure improvement (pellets) to improve its competitive advantage, marketability and field use. Several business cases have been identified in Nigeria, Ghana[1], Sri Lanka and South Africa which offer related value proposition (Rao et al., 2016). While farmers generally show a positive perception, for those who already use raw sludge (for free or a low fee), they may require field demonstrations to appreciate any other form of sludge with a higher price tag.

This chapter presents the business model on **Outsourcing fecal sludge treatment to the farm** and a supporting case from India, demonstrating how the informal business sector can support the sanitation value chain for the benefit of agricultural production.

FIGURE 191. VALUE PROPOSITIONS FOR NUTRIENT AND ORGANIC MATTER RECOVERY AND REUSE FROM SEPTAGE



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Note

1. https://goo.gl/wfCksE (accessed November 8, 2017).

CASE

Fecal sludge for on-farm use (Bangalore Honey Suckers, India)

Jasper Buijs, Heiko Gebauer, Miriam Otoo and Alexandra Evans

Supporting case for Business Model 15	
Location:	Bangalore, India
Waste input type:	Fecal sludge
Value offer:	Provision of waste removal and collection services, and fecal sludge as organic fertilizer to farmers
Organization type:	Small and medium enterprise (SME), private entity
Status of organization:	Currently in operation
Scale of businesses:	Number of businesses (fecal sludge collection trucks) operating in Bangalore is estimated to be up to 300
Major partners:	Truck and pump system supply and repair sector; municipality

Executive summary

Due to shortcomings in sewage treatment systems and the availability of a large number of cement pit latrines without good maintenance and service planning, an informal sector of micro business ventures named “honey suckers” has emerged to fulfil the market need for on-site sanitation services. “Honey suckers” is the term given to the businesses that pump the waste out of pit-latrines, septic tanks and other types of on-site wastewater treatment plants. These businesses have been successful in exploiting this opportunity for the past few years and Bangalore now has an estimated 300 of such businesses. The primary market is where honey suckers collect fecal sludge from pit latrines for a fee. The sludge is then disposed of either at an approved site (rarely) or more typically it is dumped illegally on open lands or into drains. A secondary market has emerged in which the honey suckers deposit the sludge on farmlands at the farmer’s demand, either in pits or directly on designated sites. There is usually no fee but the farmer may tip the driver. The sludge is used as a fertilizer and in some cases for the water content. The value for household is the clean removal of fecal sludge to ensure a working water closet and a clean property and environment. The value for farmers resides in obtaining nutrient-rich manure for free or for a very low fee. This model works well, because no other fast, reliable, high-quality pit cleaning service is available. The model works best when the cleaning service is easily combined with the dumping service, for which a smart network with farmers is required. The socio-economic and environmental benefits can be significant, with the creation of jobs, reduction of wild sludge dumping and associated health and environmental problems, improved sanitation and living

comfort. However, risks have to be controlled and the informal nature of honey suckers and 'illegal' aspect of the business (i.e. the supply of collected fecal sludge to the farmers) prevents monitoring of the practice.

KEY PERFORMANCE INDICATORS (AS OF 2015)						
Land use:	Limited (car park). On farm for drying and reuse					
Capital investment:	Variable depending on fleet size; cost per truck is USD 24,000 for new trucks					
Labor:	Variable, depending on fleet size, 3 people per truck					
O&M cost:	USD 7,500 year, excluding legal dumping fees					
Output:	20,000 people reached per truck per year (single homes and apartment buildings)					
Potential social and/or enviornmental impact:	3 jobs per truck, possible reduction of open-dumping of fecal sludge[1], improved sanitation and resulting waste build-up reduction					
Financial viability indicators:	Payback period:	Ca. 9 months	IRR:	98%	Gross margin:	81%

Context and background

In India, 46% of the urban population uses a septic tank, a pit or vault latrine. This population that is not connected to the sewerage network relies on different forms of self/hired services to cover their basic needs. The common services combine on-site containment such as latrines or septic tanks, with removal and off-site disposal. In the best cases, the fecal sludge is emptied at a designated site where sludge dewatering and treatment takes place. However, more often the collected fecal sludge is disposed of haphazardly and illegally, like in wetlands, thereby creating health and environmental risks. Opportunities to change this practice lie in the reuse value of the sludge, i.e. in productively utilizing this waste by capturing and using resources such as nutrients, organic matter, energy and water. Fecal sludge thus presents – like farmyard manure – a value in particular to farmers, which has been recognized by on-site sanitation entrepreneurs. Additionally, the drying of fecal sludge on farm, and incorporation in the soil represents an 'outsourcing of fecal sludge treatment' to the farm which can help mitigate the challenge of open-dumping and the related health and environmental risk. However, reuse of fecal sludge or night soil, without taking precautionary measures can pose health risks to workers, farmers and consumers.

Market environment

Many people in urban areas in Bangalore do not have access to sewage systems, or even basic sanitary services. The current sewerage network in Bangalore only serves 37% of the city's population. Moreover 53% of the total generated sewage goes untreated in the environment. Sanitation deficiency is largely prevalent in the conurbation and green belt of Bangalore. In conurbations, only 47% of households have toilets, 19% share toilets and 35% defecate in the open. In the green belt areas, only 26% of the households have toilets while 4% share toilets and 70% defecate in the open. Bangalore, like India in general, has invested majorly in the development of septic tanks, pit latrines and eco-san toilets, however, a sound plan for maintenance and services has been lacking, creating multiple problems. Waste is often disposed of haphazardly, with all the associated health and environmental consequences. A relatively large number of houses and apartment complexes have pit latrines. The existence of these circumstances and the fact that no appropriate pit cleaning management exists has created a strong market opportunity for the evolution of the informal honey sucker businesses. Another market driver is fertilizer demand, which has tended to far exceed fertilizer supply. In areas where urban dwelling is in relatively close proximity to farmland, an opportunity arose for honey sucker businesses to dispose of fecal sludge on farmlands, especially where farmers are asking for it in view

of declining soil fertility. A honey sucker business of average size serves about 20,000 people per year. Bangalore has 1.9 million households, of which 63.4% have no access to the sewage systems, and of those, 46% do have a tank or pit. With an average household size of 4.5 in Bangalore, the total serviced available market (SAM) in number of people is 2.49 million. Thus, with an average fleet of three trucks per smaller honey sucker business, and 20,000 people reached per truck per year, the market penetration (or, share of market – SOM) is 2.4% per honey sucker business. There is thus a large portion of the market that is yet untapped. On the other hand, with urban spread the transport distances and costs to reach farms around the city is increasing. Thus, the business will be most interesting for truck operators in new (unsewered) settlement areas towards the city outskirts than in its centre.

Business model

The business climate for honey sucker operations in Bangalore is different in various city areas. In the Northern part of Bangalore, there has been an intensive, but healthy competition between the honey sucker business ventures. Here, honey suckers have access to farmers and farmland that can be used as composting sites. In the Eastern part of Bangalore, this access to farmers and farmland is missing, which makes transportation distances long and expensive.

Fundamentally, the honey sucker business operates in two markets. The primary market is payment for the collection of fecal sludge from pit latrines or other onsite storage/treatment facilities. The secondary market is the 'sale' of the sludge to farmers[2]. The value for customers in the primary market is clean removal of fecal sludge to ensure a working water closet and a clean property. The value for farmers is the provision of low cost nutrients. This model works well, because no other fast, reliable, high-quality pit cleaning service is available. The model works best when the cleaning service is easily combined with the dumping service, for which a relative proximity to farm land, and a smart network with farmers is required. The socio-economic and environmental benefits can be significant, with job creation, reduction in pathogenic pressure from waste build-up and associated health and environmental problems, thus improved urban sanitation in general. However, the illegal character of the business creates problems with illegal networks, and uncontrolled dumping and land-use which may give rise to possible health risks for farmers and consumers of farm produce. See Figure 192 for the diagrammatic overview of the business model.

Value chain and position

Honey sucker businesses operate in a relatively simple value chain (Figure 193). The business has two different markets that rely on each other. The primary market, and the driving force of the business, is people who need their pit latrines emptied. The secondary market is formed by farmers who wish to make use of the sludge. The business relies on the availability of trucks adapted to the job and specialized equipment, which is available in the country. However, also secondary value chains have been observed where larger farmers dry sludge for resale to fellow farmers. The farm market might be seasonal, depending on the type of crops grown.

Institutional environment

In Bangalore, the Environmental Protection Rules and Acts of 1986 requires honey suckers to dispose of the sludge in designated areas, these being Bangalore Water Supply and Sewerage Board (BWSSB) sewage treatment plants. The reality is that few exist, which means long journeys for the truck operators, high fuel costs and a disposal fee of Rs. 50/kilolitre (0.82 USD/kilolitre). Instead truck operators dispose of the waste into open drains or onto wasteland. In some cases the truck operators have made arrangements with farmers who receive the waste and either use it directly on their fields, thereby making use of the water content, or store it and compost it over a period of time. The

FIGURE 192. HONEY SUCKER BUSINESS MODEL CANVAS

KEY PARTNERS

- Truck and pump systems suppliers and repair services
- Municipality

KEY ACTIVITIES

- Collecting sludge
- Transporting and disposing of sludge
- Marketing (customer generation)

KEY RESOURCES

- Truck(s) (capital)
- Labor, 3 people per truck
- Driver–farmers network
- Household and apartment base
- Loyalty of truck drivers, fortified by right to claim tipping fees

VALUE PROPOSITIONS

- A fast and affordable fecal sludge removal service for citizens, improving the household and city environment
- Free/low-cost 'human manure' for farmers, who will save on costs for fertilizer.

CUSTOMER RELATIONSHIPS

- Personal help at contractual agreements (apartment blocks)
- Personal help (ad-hoc)

CHANNELS

- Telephone marketing
- Trucks, leaflets and banners advertising
- Informal, word of mouth

CUSTOMER SEGMENTS

- Households, apartment blocks and institutions with septic tanks or pits
- Farmers

COST STRUCTURE

- Truck maintenance
- Truck fuel
- Labor wages
- Legal dumping/tipping fees (not always done)

REVENUE STREAMS

- Pit latrine emptying fees
- Informal fees for manure plus possible savings on transport costs and tipping (desludging) fees

SOCIAL & ENVIRONMENTAL COSTS

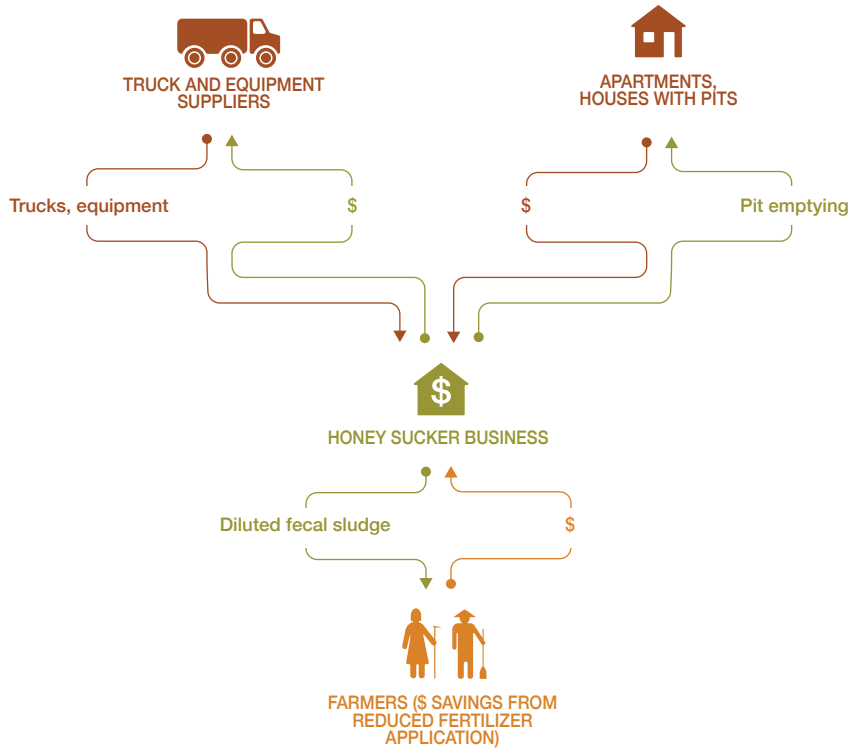
- Human health risk arising from use of fecal sludge on farms without proper regulation and training in safety options
- Operating ex-legally strengthens illegal networks

SOCIAL & ENVIRONMENTAL BENEFITS

- Improved sanitary situation citizens
- Reduced city-internal fecal waste pressure and related health and environmental problems
- Increased land fertility where fertilizer prices are prohibitively expensive for poor farmers

business of honey suckers supplying collected fecal sludge to farmers suggest that it is a desirable commodity, which acts as a means of effectively and cheaply dealing with the sludge. However this activity is not supported by legislation (although some government officials state that fecal sludge is implied in the Fertilizer Control Order which permits the use of animal dung). There are no effective policies and regulations in place for either pit emptying or reuse on agricultural land. Standards would however be important to reduce the risks to workers, farmers and consumers of farm produce which may be contaminated with pathogens. The urban governance structure in India is highly complex

FIGURE 193. VALUE CHAIN OF HONEY SUCKER BUSINESS



with overlapping as well as weak mandates. The result of institutional complexities combined with a lack of funds is described as 'local governments operate in an implementation muddle', demanding improvisation, flexible interpretation and inviting the bending of rules and corruption.

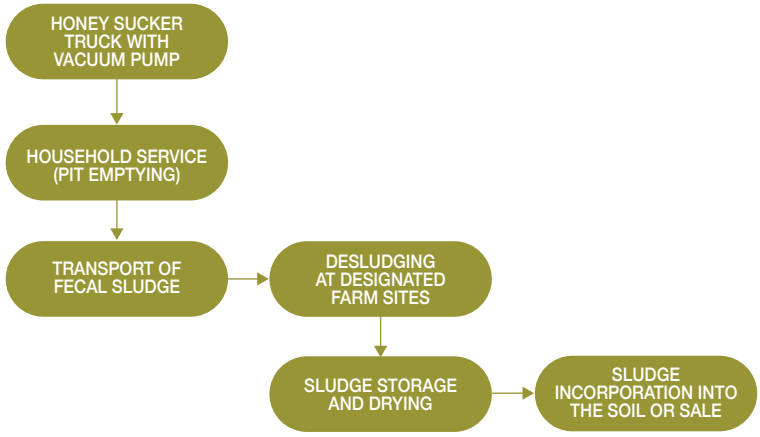
Technology and processes

Honey suckers operate with dedicated trucks with a storage tank, which have a (vacuum) pumping system to suck up the sludge and an opening for desludging of their load. An increasing number of trucks are being manufactured in the country. Besides normal maintenance of the trucks and their equipment, there is little requirement for specialized maintenance services or training. Depending on the age of the sludge in the pit, and its hardness, truck operators might need access to water for sludge dilution and removal. On farm, the sludge might be stored and dried in larger pits (usually over about three months) before it is applied to the crops, e.g., to coconut trees. Wet fecal sludge can also be 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. Some farmers also sell dried sludge to other farmers (Figure 194).

Funding and financial outlook

An enterprise typically starts with an entrepreneur initiating a honey sucker business until it reaches about three to four trucks. The initial investment requirements for starting a honey sucker business venture are relatively low. It needs only a telephone number, a dedicated and registered truck, and a driver and two assistants per truck. Capital injection is required for establishing a truck fleet. Costs

FIGURE 194. PROCESS DIAGRAM FOR COLLECTION AND REUSE OF FECAL SLUDGE



for one (new) truck are about USD 24,000. Major variable costs are related to truck maintenance and operation, labor wages and fuel for the trucks. These costs accrue to about USD 7,500 per year. Legal dumping fees are an additional cost, but turn into revenue if farms are the target. Because most of the businesses are not registered, considerable costs are incurred avoiding fines, and an opportunity loss is incurred due to business scaling limitations. In the current setting, the only, but profitable, revenue stream is from pit emptying fees, which amounts to a maximum USD 27 per pit emptied. With four services per day, 30 days per month, the revenues accrue to about USD 39,000 per truck per year and profit is estimated at about USD 31,500 per year. Thus, the payback period is nine months, with an IRR of 98% and a gross margin of 81%. Revenues are highest in the monsoon season, when servicing is required more often due to rainfall and overflowing pits. Drivers take tips from farmers for delivering sludge to their farms. However, the larger benefit can be savings on petrol (and desludging fees) if the farm is closer to the pit than the official dumping site. In more conducive legal-institutional settings, revenues could increase based on contractual customer relationships. Also specialized services such as ensured environmentally friendly dumping or guaranteed-time collection could be offered. Moreover, an official and larger customer base would allow businesses to perform more sophisticated services.

Socio-economic, health and environmental impact

Sewers are expensive and water to flush them increasingly rare. This gives on-site sanitation system an important place on the urban sanitation agenda. Due to the booming business of emptying pit latrines and holding tanks with honey sucker trucks, less fecal sludge finds its way into city drains and waterways, and household facilities function better. Disposal to farmlands outside the city offers the advantage of controlled drying and soil application, and improved crop production, but it needs oversight and risk reduction measures. The risks to farmers and potentially consumers are manageable without particular costs as long as the sludge can be well dried, crop restrictions are in place, and farmers wear protective gear (Keraita et al., 2014; WHO 2006). In this case, several social and environmental benefits could be attributed to honey sucker businesses as a valuable component of the sanitation service chain.

Scalability and replicability considerations

Honey sucker businesses thrive in places where sewage service is minimal and where people require affordable, fast and reliable sanitation services (Rao et al., 2016). The business requires a high density

of easily accessible pits. There must be dedicated trucks available, with suction pumps. If the waste is to be provided to farmers, they must be within an economically viable radius (i.e. closer than official dumping sites or alternative illegal dumping sites currently are). While sludge supply is year-round, agricultural demand depends on cropping systems and might be seasonal. Another major restriction to honey sucker business growth in Bangalore is the lack of a supportive legal framework, which also links to the availability of farmers interested in the sludge. Currently businesses operate on a small scale, avoiding official marketing systems such as yellow pages and websites, and avoiding penalties. A legal standing would reduce the cost of acquiring new customers and improve access to finance. In such a situation, honey sucker businesses could follow multiple avenues to expand their operations: use of their specialized knowledge in advisory roles; offering improved services, e.g. time-guarantee arrival and emptying, eco-friendly processes (customers explicitly mention their willingness to pay for guaranteed environmentally safe handling and disposal); production of safe compost and information services to farmers.

Summary assessment – SWOT analysis

Figure 195 presents an overview of the SWOT analysis for the honey sucker business model. Due to shortcomings in the sewage systems, and the availability of a large number of cement pit latrines

FIGURE 195. SWOT ANALYSIS FOR INFORMAL FECAL SLUDGE REUSE IN BANGALORE

	HELPFUL TO ACHIEVING THE OBJECTIVES	HARMFUL TO ACHIEVING THE OBJECTIVES

INTERNAL ORIGIN
ATTRIBUTES OF THE ENTERPRISE
	STRENGTHS
	▪ Low capital investment
	▪ Only affordable, reliable emptying service available for people without sewage systems or with sub-standard ones
	▪ Positive influence on sanitary situation in urban areas
	▪ Virtually unlimited supply
		WEAKNESSES
		▪ No legal standing which creates other weaknesses:
		  ▪ Limited access to affordable finance
		  ▪ Must make additional efforts to avoid penalties
		  ▪ Marketing difficulties including use of economies of scale
		  ▪ No support in view of health protection
		▪ Requires climates with sufficiently long dry periods for sludge drying
		▪ Agricultural demand might be seasonally limited for some crops

EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Legalization leading to opportunities to increase scale ▪ Higher health standards and sustainability offer avenues for qualitative service offers ▪ Decreasing land fertility and rising fertilizer prices drive growth of business ▪ Increasing urban populations drive growth of business	**THREATS** ▪ New sewage lines developed in underserved areas destroy honey sucker market ▪ Legalization incurs additional costs for waste disposal, administration

without good maintenance and service planning, an informal sector of micro-business ventures named 'honey suckers' has emerged to fulfil the market need for on-site sanitation services. This model works well, because no other fast, reliable, high-quality pit cleaning service is available in the city. With very limited capital investment requirements and a strong revenue stream from pit-emptying services, this model offers entrepreneurs an opportunity for recouping their investment in a very short time period and with a relatively high gross margin. Although profitable, the honey sucker business is a highly risky investment option as their activities occur in a legally restrictive environment with significant uncertainty. This has implications for business sustainability and any scaling-up opportunities. Legalization of these initiatives may positively influence the honey sucker sector although there is some concern, especially among NGOs, honey suckers and farmers, that legalization and regulation may reduce its viability.

Contributors

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Sharada Prasad C.S., UC Berkeley, USA

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For a photographic journey please see: http://arghyam.org/wp-content/uploads/2013/07/Honeysuckers-S-Vishwanath.pdf and www.flickr.com/photos/sharadaprasad (both accessed November 8, 2017).

See also: www.downtoearth.org.in/coverage/shit-its-profitable-47389 (accessed November 8, 2017).

Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2015/16. As business operations are dynamic data can be subject to change.

Notes

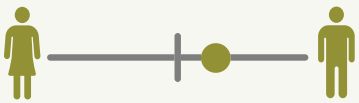
1 While sludge disposal on farmland can reduce wild dumping of fecal sludge, the actual contribution has not been quantified as many farms might be too far away (transport costs) or their demand seasonally limited.
2 These fees are important as they reverse the normal process where drivers pays a tipping fee at a formal treatment pond. Thus, even if the token does not necessarily enter the business' revenue stream, there are savings, and it is a means for creating a trusted relationship with the driver. However, while earlier, farmers were approaching vehicle owners to have the sludge dumped into their fields, there is today much competition among trucks, and drivers are increasingly seeking farmers willing to accept sludge. The situation is different e.g. in Dharwad where larger farmers organize interim sludge storage and after drying auction the material.

BUSINESS MODEL 15

Outsourcing fecal sludge treatment to the farm

Jasper Buijs, Pay Drechsel and Miriam Otoo

Key characteristics

Model name	Outsourcing fecal sludge treatment to the farm
Waste stream	Fecal sludge (FS)
Value-added waste product	Organic fertilizer, waste removal and collection services
Geography	Urban population with no connection to sewerage network and use on-site containment such as latrines or septic tanks with off-site disposal. Dry climate over 3+ months for on-farm sludge drying before application.
Scale of production	Small to medium sized service operation; 20,000 people reached per truck per year (single homes and apartment blocks)
Supporting case in this book	Bangalore, India (with additional lessons learnt from Northern Ghana)
Objective of entity	Cost-recovery [ ]; For profit [X]; Social enterprise [ ]
Investment cost range	Variable but low; depending on fleet size, per truck ca. USD 24,000 (new)
Organization type	Private
Socio-economic impact	Jobs (3 people per truck), reduced disposal costs, agricultural production increase, sanitation improvement, living comfort increase
Gender equity	Primarily more benefits accrue to men who farm crop plantations and male drivers of vacuum trucks who gain from improved desludging and disposal measures 

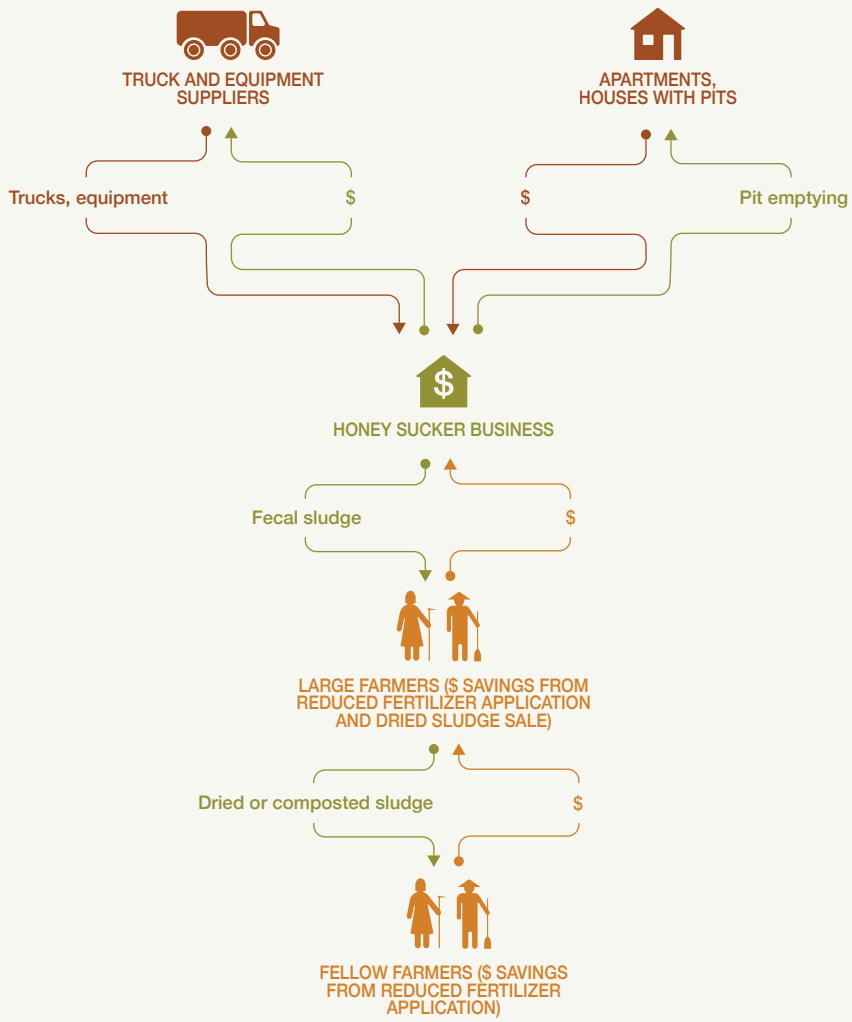
Business value chain

This business model can be used by private enterprises in smaller and larger towns and cities with a significant share of on-site sanitation facilities like septic tanks and cement pit latrines at households or office/apartment blocks in need of servicing (desludging). In the primary market, the business will collect fees from the household for collecting the fecal sludge (septage). In the secondary market the sludge is sold to peri-urban farms or plantations where the material is treated on-site, potentially composted and used as manure (Figure 196). The value for customers in the primary market is clean removal of fecal sludge to ensure a working water closet and a clean property. On the secondary market, the sludge supports crop growth on even unfertile soils, easily replacing commercial fertilizer, which can represent significant savings for the farmer while reducing the disposal/pollution costs for the city. The truck operator gains significantly economically if the farm is closer than the official dumping site and due to a reversed cash flow: instead of paying a tipping fee, the farmers pay the drivers. This model works best where farmers have no objection to the use of fecal sludge, know how

to treat it safely and official dumping sites are far out of town. As farm demand might be seasonal, sludge that cannot be sold to farmers must be legally dumped.

An alternative scenario in the secondary market is that a farmer has multiple partnerships with different truck operators to deliver sludge to the farm. The farmer treats the sludge through sun drying (e.g. over 6 months like in Dwarward, Karnataka) and sells/auctions the treated dried sludge as fertilizer to other farmers. Compared to conventional septage collection from households and disposal in treatment ponds, the model has increased safety issues due to sludge disposal on farm and its possible link to the food chain. On-farm treatment, hygiene and crop restrictions must be strictly managed in this model, unless the fecal sludge is professionally dried and sanitized in a dedicated facility before being sold to farmers.

FIGURE 196. VALUE CHAIN SCHEMATIC – OUTSOURCING FECAL SLUDGE TREATMENT TO THE FARM



This type of business operates in a relatively simple value chain, and has two different markets that rely on each other. The primary market, and the driving force of the business, is the one where people are in need of on-site sanitation service, to clean out pit latrines where houses, apartment blocks, etc. in urban areas have no connection to sewage systems. The secondary market is formed by farmers who are interested in buying the fecal sludge for use on their land, thus saving on fertilizer costs, or for drying/composting and resale to fellow farmers. The business relies on availability of adapted trucks and specialized equipment.

Business model

The primary concept of the business model is to provide on-site sanitary cleaning services to households in the city by collecting fecal sludge from households' pit latrines, and provide nutrient-rich sludge to peri-urban farmers as a form of cheap 'manure' (Figure 197). A private enterprise operates throughout (parts of) the city, providing pit latrine emptying services to households and apartment blocks that have no connection to sewer systems or any other effective on-site sanitation treatment service. The service is based on the operation of fecal sludge emptying trucks that have specialized equipment on board to flush, suck up and store fecal sludge. The overall investment required for this type of business is relatively modest, with major investments required only for buying trucks (ca. USD 24,000 for each new truck, not counting for variation per country). The business makes a contribution to improvements in the environment through reduction of fecal sludge-based pollution in the city and related possible contamination of water bodies. It provides an important sanitation service where sewer systems are not available, and offers an opportunity for farming communities to improve soil quality with minimal investment. The business, however, may be prone to seasonality unless perennial crops are grown, and suffer from ex-legal status. The best business conditions arise where the use of fecal sludge on farms is legal, like the use of manure, but also, where the safety of such business systems is thoroughly investigated and where regulation compliance is monitored and incentivized.

Alternate scenarios

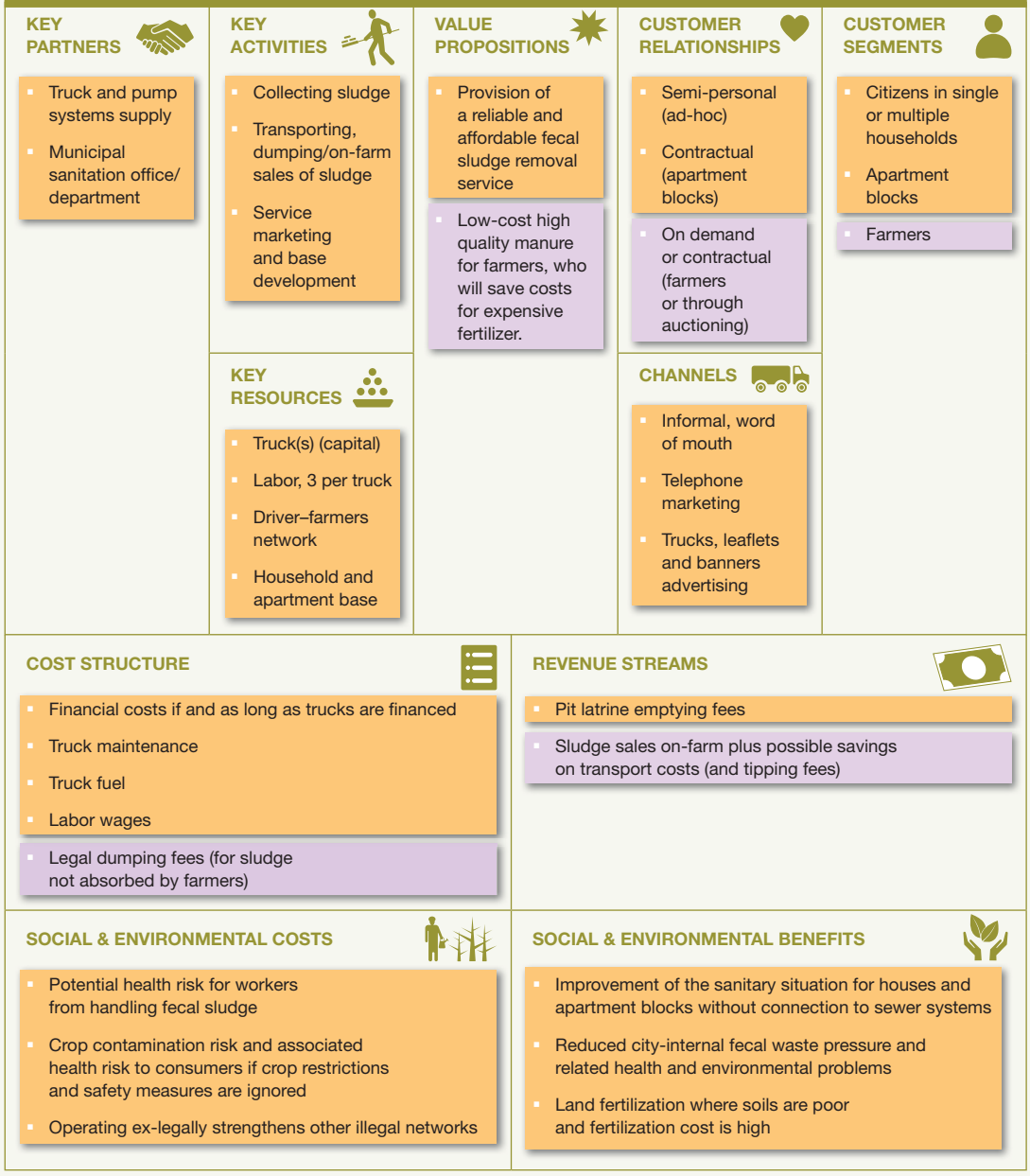
In an alternative, legal (but hypothetical) model the enterprise will be operating with a larger fleet of trucks. This model builds on the possibilities that arise when raw fecal sludge reuse on farms is permitted and regulated. The enterprise is a public-private-partnership in which the private partner, having the materials and equipment as well as operative expertise, gains operational freedom leveraged through its public partner (e.g. a municipal sanitation body or a government-owned operation). Operations will be bound to strict selection of complying farms (monitored), but the enterprise also gains the advantage of economies of scale, enabling the transition to improved value offerings, such as 'eco-friendly fecal sludge removal' or 'guaranteed time of pick-up of fecal sludge'. The enterprise invests in and gains from extensive expertise on fecal sludge removal and pit latrine construction and cleaning knowledge. Competition from micro and small enterprises of the same sort is minimal because of value proposal superiority and operational freedom arrangements. Costs are incurred for monitoring of compliance, also at farming sites in the network. This model strongly reduces negative externalities such as health risk to consumers of farm products, and illegal networks.

Potential risks and mitigation

The business model presented here was designed and optimized based on the analysis of previous studies and a case study. In designing this optimized business model, risks decribed below were addressed. However, risks defined below would continue to remain and are hence acknowledged.

Market risks: Market risks in terms of accessing fecal sludge are minimal, unless there are plans to extend the coverage of the sewer system. Market risks in terms of accessing farm land can occur

FIGURE 197. BUSINESS MODEL CANVAS – OUTSOURCING FECAL SLUDGE TREATMENT TO THE FARM



Note: Fecal sludge household collection service (market 1) and safe on-farm use (market 2).

outside the season of fertilizer application, unless different perennial crops are grown which can absorb fecal sludge throughout the year. Market risk in terms of consumer acceptance could become a factor where crops are not mixed in markets.

Competition risks: Competition risk for small-scale business is high, with low new entry barriers.

Technological performance risk: The business relies on availability of specialized trucks and equipment, as well as parts and repair expertise for the same. If such are imported, a real technological risk exists.

Political and regulatory risks: Regulatory risks exist for the business as long as they operate in an ex-legal manner (which is common practice rather than exception). The ex-legal character forms a barrier to enterprise growth and maturation. Legalization of the business and associated regulation and compliance forms a further complexity to this type of business.

Social equity related risks: This business model does per se not create any particular social inequity, but this depends on the type of crops used and the associated gender. As ideally perennial plantation crops are preferred, the model might in many cultures favour men who have better access to land and capital. Also, most truck drivers will be male. Otherwise, the model rather contributes to ensuring that households using non-sewered systems have access to waste collection services. This is because cesspit operators now have 'informal' designated disposal sites and are thus incentivized to provide services to a larger proportion of the population.

Safety, environmental and health risks: Health risks exist for personnel operating latrine emptying trucks. Serious health risks to consumers of farm products exist where the model is employed ex-legally, and sludge handling practices on farms do not follow basic safety recommendations. Risk mitigation options are known and should be sought, like protective clothing for workers and farmers, and monitored farming practices such as crop restrictions, sufficient time for sludge drying and safe sludge application (Table 46).

TABLE 46. POTENTIAL HEALTH AND ENVIRONMENTAL RISK AND SUGGESTED MITIGATION MEASURES FOR BUSINESS MODEL 15

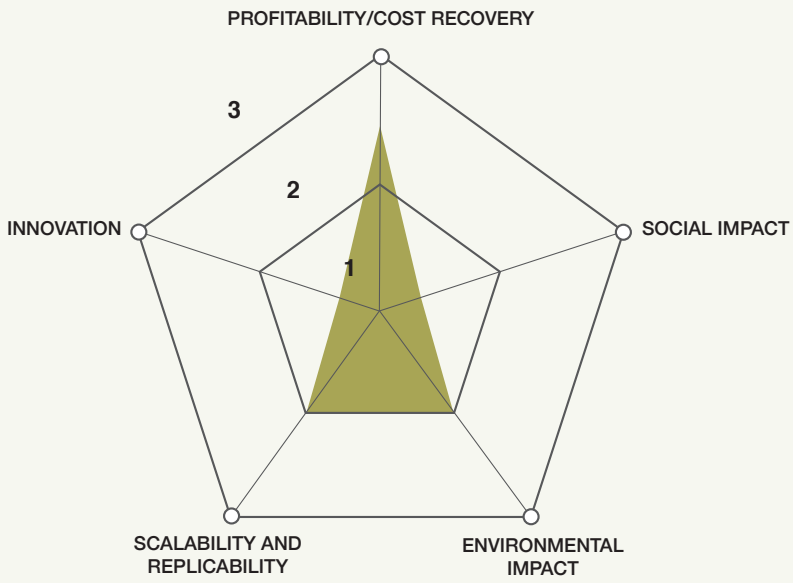
RISK GROUP	EXPOSURE					REMARKS
	DIRECT CONTACT	AIR/DUST	INSECTS	WATER/ SOIL	FOOD	
Worker						At farm level, sufficient drying time for the sludge and crop restrictions are recommended, as well as personal protection (gear and hygiene) from sludge collection to farm work See Stenström et al. (2011) and Keraita et al. (2014) for more details on risks and risk mitigation
Farmer/user						
Community						
Consumer						
Mitigation Measures						

Key: NOT APPLICABLE; LOW RISK; MEDIUM RISK; HIGH RISK

Business performance

The business model scores high on scalability, environmental impact and profitability (Figure 198). This business model may thrive in places where sewage services are minimal and where people require affordable, speedy, on-the-spot sanitation services. A strong driver for the business is the large availability of pit latrines that are accessible by truck, and the availability of local vacuum truck

FIGURE 198. RANKING RESULTS FOR OUTSOURCING FECAL SLUDGE TREATMENT TO THE FARM BUSINESS MODEL



manufacturers. There is need for farming activities in proximity with ample (ideally year-round) demand for sludge, like via perennial (tree) crops. Although driving the ease of entry, an ex-legal climate for the business operation also forms the major restriction of business growth, because official marketing systems such as yellow pages and websites are avoided to steer away from penalties. The development of a conducive legal-institutional framework would benefit the industry greatly.

Under the right circumstances, i.e. a legally conducive framework, companies will be able to grow and make use of economy of scale principles. The cost of acquiring new customers then are lower, as well as the cost of accessing and buying finance. In such a situation, this type of business could follow multiple avenues to vertically scale their operations: 1) through the exploitation of their growing specialized knowledge (e.g. of construction details and cleaning ease, efficacy) towards 'smart' sanitary solutions advice and consulting; 2) by bringing customers new quality offers services (e.g. time-guarantee arrival and emptying, guarantee towards eco-friendliness – customers explicitly mention their willingness to pay extra if they can be sure the entrepreneur's handling of the waste is guaranteed to be environmentally safe); 3) by development toward production of safe compost that will allow sales of compost to farmers and companies, and information services to farmers for safe handling and use of sludge for composting and crop growing; and finally 4) by offering maintenance service for 'smart' latrines that are built to fit the housing and offer higher safety, e.g. monsoon times or are easier to clean and empty. For scaling towards eco-friendliness, more emphasis would have to be put on the secondary market, the services to farmers. Stronger relationships, built on solid trust, would have to be developed. In the long run, these businesses would need to spend more effort in design and cleanliness of trucks, the appearance and training of personnel, and increasingly good handling of sludge, to sell their services to increasingly developed and richer communities.

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13. BUSINESS MODEL ON PHOSPHORUS RECOVERY FROM EXCRETA AND WASTEWATER

Introduction

Among the essential plant food nutrients, phosphorus (P) is of particular interest as it is a non-renewable (finite) resource and means of its production other than mining are unavailable. With about 90% of known phosphate rock reserves found in only a few countries, the slowly declining reserves have stimulated a lively discussion ("Peak phosphorus") on sustainable P management and P recovery before it ends in waterways (Cordell et al., 2011; Edixhoven et al., 2014; Sartorius et al., 2012).

According to Latimer et al. (2016), phosphorus (P) recovery in the form of struvite is for now the most established technology for facilitating extractive nutrient recovery at scale during wastewater treatment. Nitrogen-only recovery is also feasible but has not been implemented extensively. Taking this into account, Latimer et al. (2016) estimated that the existing domestic wastewater treatment industry can optimistically bring between 100,000 and 210,000 metric tonnes of P_2O_5/yr (as struvite) and up to 220,000 metric tonnes N/yr to the fertilizer market. Although this corresponds only to 2–5% of the global P_2O_5 and N fertilizer demand, the sector is expected to grow. Moreover, in financially more rewarding niche markets, like fertilizer for ornamental plants, already between 30% and over 100% could be covered.

A particular interesting source for P recovery is human excreta[1]. Each year, the average human excretes up to 500 litres of urine and 50–180 kg (wet weight) of feces depending on water and food intake. Comparing feces and urine, most of the nutrients, i.e. 88% of the nitrogen, 67% of the phosphorus, and 71% of the potassium are found in the urine (Drangert, 1998). For low-income countries, there are three broader options for accessing and recovering P from human excreta, which are in order of increasing scale:

a) Collecting separated urine and feces at source (toilet), for urine use as liquid or crystal mineral fertilizer;
b) Collecting mixed excreta (septage) from unsewered systems, for use as organic fertilizer (fecal sludge composting);
c) Extracting P crystals during or after sewage treatment, for use as inorganic P fertilizer.

a) Collecting excreta before they are mixed with other potentially harmful waste streams appears most straight forward. Given the different nutrient amounts in feces and urine, and also the differences in pathogen loads, an ideal system collects both fractions separated, like in urine diverting dry toilets (UDDTs). The separated products can be safely treated and reused in agriculture ideally directly at household level (gardens). However, where households have no space, means or interest in reusing the produced excreta, collection services can be set up, where – depending on available alternatives – households either pay a fee for being served or receive payment for the provided waste resource. Different models are possible:
   - **Decentralized excreta collection from households with UDDTs**. This has been tried at scale, e.g. in Ouagadougou (see **case example** following) with resale of the recovered and treated resources to farmers. There are very few similar examples yet to promote a particular business model. From a financial perspective, success is so far mixed, especially when the provision of the UDDTs is included (WSP, 2009). Additional challenges, like in the case of Ouagadougou, are the high management overheads to organize excreta collection and distribution as well as the related (urine) transport costs.
   - A related business model is to focus on the **collection of urine from large one-point supply sources** such as sport arenas, youth hostels, prisons, industrial fares, music-, business- or entertainment-parks, universities and colleges, research institutes, etc. which are (or can be

temporarily) equipped with normal urinals or UDDTs. This model avoids the costs of dealing with multiple clients as well as expenditures related to transport and logistics. The Dutch GMB[2] Bioenergy company in the Netherlands runs such a business using the SaNiPhos® process for urine treatment. The plant has been operating since 2010 and sourcing urine from music festivals, treating about 1300m^3 of urine per year. Each cubic meter of urine yields 3–4kg struvite (solid fertilizer) and about 60kg ammonium sulphate (liquid fertilizer). In another Dutch example, Amsterdam's water company (Waternet) and water authority Amstel, Gooi and Vecht recover phosphate in a special phosphate factory since 2013. They targeted Amsterdam's five-day maritime festival in 2015 to harvest about 100m^3 of urine. The expected 140 kg of struvite will be used in three innovative urban greening projects by the Amsterdam Rainproof platform[3]. A significant disadvantage of urine collection is its large water content and related volume and weight. The most common method for reducing the urine volume is through P precipitation (Pronk and Koné, 2010) as used in the examples above which can be catalysed through the addition of magnesium and results in "struvite" which is a soft P-crystal ($NH_4MgPO_4 \cdot 6H_2O$). The process has been piloted in many countries, like in Nepal, and can be financially viable unless magnesium access becomes too expensive (Tilley et al., 2009; Etter et al., 2011). An alternative option could be membrane filtration. Urine collected during a music festival in Ghent, Belgium, has been heated in larger (e.g. solar powered) tanks before passing it through a membrane which separates the nutrients and recovers the water in the urine[4].

b) Where urine and feces are not separated, and collected in latrines or septic tanks, resource recovery can transform the generated and collected septage during treatment into a safe organo-mineral compound fertilizer for example through drying and composting or co-composting (Nikiema et al., 2014). The compound nature of the material with different macro- and micro-nutrients has its own value proposition and business models (Rao et al., 2016). In many developing countries where treatment plants are too expensive, the agricultural use of nutrient rich (composted) sludge from septic tanks can be the most cost-effective option. This does not apply to sewage sludge, which with increasing industrialization has a growing risk of chemical contamination limiting its direct reuse potential. For sewage sludge, other P extraction options exist (see next point).

c) Where households are connected to sewers, and the excreta are flushed away, the process of extracting at this stage nutrients is increasingly complex and costly. However, to protect water bodies from eutrophication and treatment plants from unwanted phosphorus crystallization (valve and pipe damage), a large array of technical options is available to not only remove but recover different percentages of reusable P from wastewater and sludge during or after the treatment process (Egle et al., 2014; Latimer et al., 2016). These technologies have different requirements on the treatment process and energy and not all might be suitable for developing countries. However, especially in larger plants, they offer an important value proposition for saving maintenance costs, next to the generation of high quality Ca or Mg based P crystals with potential for use as fertilizer.

In this section we will describe two examples from the spectrum of opportunities listed above, one as a **case study** (Ouagadougou) and the other as **a model** (**P extraction from sewage treatment**). The Ouagadougou case was selected as a promising but also highly subsidised attempt for going at scale without qualifying yet as a model recommended for replication. The other case is based on P extraction from sewage treatment using the approach of Ostara (Canada) as an example. Given the success of the Ostara model, the example was chosen as a ***business case*-cum-*business model*** based on data from Ostara's operations in Canada, USA, and Europe and application potential also in middle-income countries. It is however important to add that there exist a wide array of other companies, processes

and technologies for P recovery with different advantages for different situations and recovery targets (Sartorius et al. 2012; Egle et al., 2014).

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Notes

1 Urine and feces together are called excreta.
2 http://www.gmb-international.eu (accessed November 8, 2017).
3 https://amsterdamsmartcity.com/projects/amsterdam-rainproof (accessed November 8, 2017).
4 http://firstwefeast.com/drink/2016/07/scientists-discover-way-to-turn-urine-into-beer (accessed November 8, 2017).

CASE

Urine and fecal matter collection for reuse (Ouagadougou, Burkina Faso)

Miriam Otoo and Linus Dagerskog

Supporting case for Business Model 16	
Location:	Ouagadougou, Burkina Faso
Waste input type:	Urine and feces
Value offer:	Provision of sanitation services and sanitized urine and feces as a safe organic fertilizer for agricultural production
Organization type:	Public-private partnership
Status of organization:	Project started in 2006, full system operational in 2008/2009
Scale of businesses:	Collection, treatment and reuse: 75,000 litres of urine and 11 tons of fecal sludge/year
Major partners:	European Union (EU), Water and Sanitation for Africa (WSA, formerly known as CREPA), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), National Water and Sanitation Authority (ONEA), Municipality of Ouagadougou

Executive Summary

The ECOSAN-EU initiated project was selected as a unique example of a large-scale household based resource recovery venture, while providing urban farmers with a reliable nutrient source for agricultural production. As with many other rapidly growing cities in the developing world, Ouagadougou is representative of a huge nutrient sink – where massive amounts of nutrients brought into the city with food are not recycled back to productive land. Coupled with poor waste management practices, especially the risk of groundwater contamination from the accumulation of human excreta in deep-pit latrines and septic tanks, the current waste management approach has dire effects in terms of soil fertility loss, increased disease burden and eutrophication. The project's activities which cuts across the entire sanitation value chain via the provision of sanitation products and waste collection services, whilst having a direct linkage to the agricultural sector via the conversion of human excreta into organic fertilizers for supply to local farmers, represents a sustainable market-driven solution especially in the absence of political pressure. The initial pilot phase of the project, from June 2006–December 2009, was set up with funding from the EU with contributions from the implementing organizations, GIZ, CREPA and ONEA. The EcoSan system was implemented in four of Ouagadougou's 30 urban sectors and the project was engaged in the provision of household urine diverting latrines, decentralized collection and treatment of urine and feces and the sale/delivery of the treated excreta as fertilizers for crop production. A key characteristic of the

project has been its transfer of ownership to the municipality of Ouagadougou in 2010 and strong engagement of community-based organizations (CBOs) in different business activities along its value chain. The ECOSAN-EU business model is based on a CBO approach where in each urban sector, one group association or community-based organization (CBO) has a contract with the municipality to ensure the collection, treatment and delivery of sanitation products from households to farmers. A key success factor for this model has been the diversification of their portfolio as represented by the multiple products and services they provide. The variable income for the associations include monthly collection fees of USD 0.69 per UDDT (urine diversion dehydrating toilet), income from sales of EcoSan fertilizers (sanitized urine and feces sold at USD 10.37/m^3 and USD 5.34/50kg bag, respectively).

ECOSAN-EU has contributed to improved health and hygiene of households with installed UDDTs and offers a monthly collection service comparatively cheaper than having a one-off pit emptying service. Improved excreta management practices has resulted in a reduction of environmental pollution. Additionally, the activities of this project have created a significant number of jobs along the entire sanitation value chain and provided a low-cost and sustainable agricultural input alternative for farmers.

KEY PERFORMANCE INDICATORS (AS OF 2014)						
Land use:	Data not available					
Capital investment:	USD 20,145 per year					
Labor:	Data not available					
O&M cost:	USD 3,319–3,651 per sector per year					
Output:	223,760 litres of sanitized urine and 21 tons of solid fertilizer over a 3-year period					
Potential social and/or environmental impact:	Improvement in health and hygiene of households with installed UDDTs, creation of jobs, reduction in environmental pollution, low-cost fertilizer for farmers					
Financial viability indicators:	Payback period:	N.A.	Post-tax IRR:	N.A.	Gross margin:	N.A.

Context and background

Only 19% of the population in Ouagadougou, Burkina Faso, had access to improved sanitation (i.e. increased waste collection and treatment services) in 2006. With an annual population growth rate of around 5%, it has become increasingly difficult for municipalities to keep up with that with the provision of sanitation services. Large quantities of human excreta accumulating in deep-pit latrines and septic tanks not only represent a potential risk for groundwater contamination but are also wasted nutrient resources. An integrated ecological sanitation (EcoSan) system was implemented in 2006–2009 by the EU-funded ECOSAN-EU project led by WSA (Water and Sanitation for Africa), GIZ[1] (Deutsche Gesellschaft für Internationale Zusammenarbeit) and ONEA (National Water and Sanitation Authority). The key activities of this project were to support 1,000 households in obtaining appropriate and affordable, urine diverting dry toilets (UDDTs) with an associated collection service followed by treatment and reuse demonstrating novel excreta management systems that protect human health, contribute to food security and enhance the protection of natural resource and promote small and medium size enterprises. The project was implemented in four of Ouagadougou's urban sectors – "arrondissement" 17, 19, 27 and 30. Public UDDTs were initially installed at the central prison of Ouagadougou, the Bangrweogo Park, town hall and the zoo. Subsequently, households were willing to install UDDTs after the subsidies were increased, and within six months, 400 double vault UDDTs were built. By June 2009, 922 homes were using UDDTs and some 800 gardeners and small-scale farmers were trained on the application of treated urine and feces for their crops. The Ouagadougou municipality took over the coordinating role from January 2010 when the project was officially completed, after a

transition phase of six months. The municipal waste department (or "Department for Cleanliness" - Direction de la Proprété) set up an EcoSan committee, which has a chairman, one rapporteur and one focal point. A municipal budget line was dedicated for continued support to the associations. The total investment for the three-year project (2006–2009) was USD 2,070,218. In 2010, the municipality of Ouagadougou allocated USD 14,735 of its budget for continued support to the service providers (local CBOs), and took over the coordinating role of the project. The waste management regulations of Burkina Faso are such that the municipalities organise the collection, treatment and disposal of waste, which can be carried out in partnership with private organisations and Decree 95 indicates the setting up of a fee for household waste collection. The ECOSAN-EU is based on a concept where in each urban sector, a community-based organization (CBO) has a contract with the project to ensure the collection, treatment and delivery of sanitation products from households to farmers.

Market environment

With increasing waste management costs but ever-dwindling budgets, municipalities are in dire need of sustainable alternatives such as integrated ecological sanitation solutions involving the reuse of waste in cities like Ouagadougou. Additionally, Burkina Faso is a landlocked country, affected by droughts and desertification, overgrazing, soil degradation and deforestation, with only 14.43 % of its land being arable. Around 90% of the population is engaged in subsistence agriculture and with unpredictable chemical fertilizer prices, exemplified by the price hike in 2008, reuse of treated human excreta can be a reliable nutrient recovery strategy for agriculture. This represents opportunities for business development in both the sanitation and agricultural value chains. It is important to note that although the demand for sanitation infrastructure (i.e. UDDTs) and services will demonstrate an increasing trend for the next decade, human fertilizer demand at least in the city may not reflect a similar trend. Factors related to transportation constraints especially for sanitized urine and the current area of urban agriculture within city limits may potentially limit the amount of excreta that can be absorbed in the agricultural sector, suggesting an excess supply. Based on 2012 data, the present farming activities in the city can potentially only absorb the excreta from approximately 50,000 people, whereas there are 1.5 million inhabitants in Ouagadougou. New technologies to add-value to urine and feces such as pelletized fecal sludge-based compost will allow businesses to access new markets beyond the city limits, as realized for example in Accra, Ghana.[2]

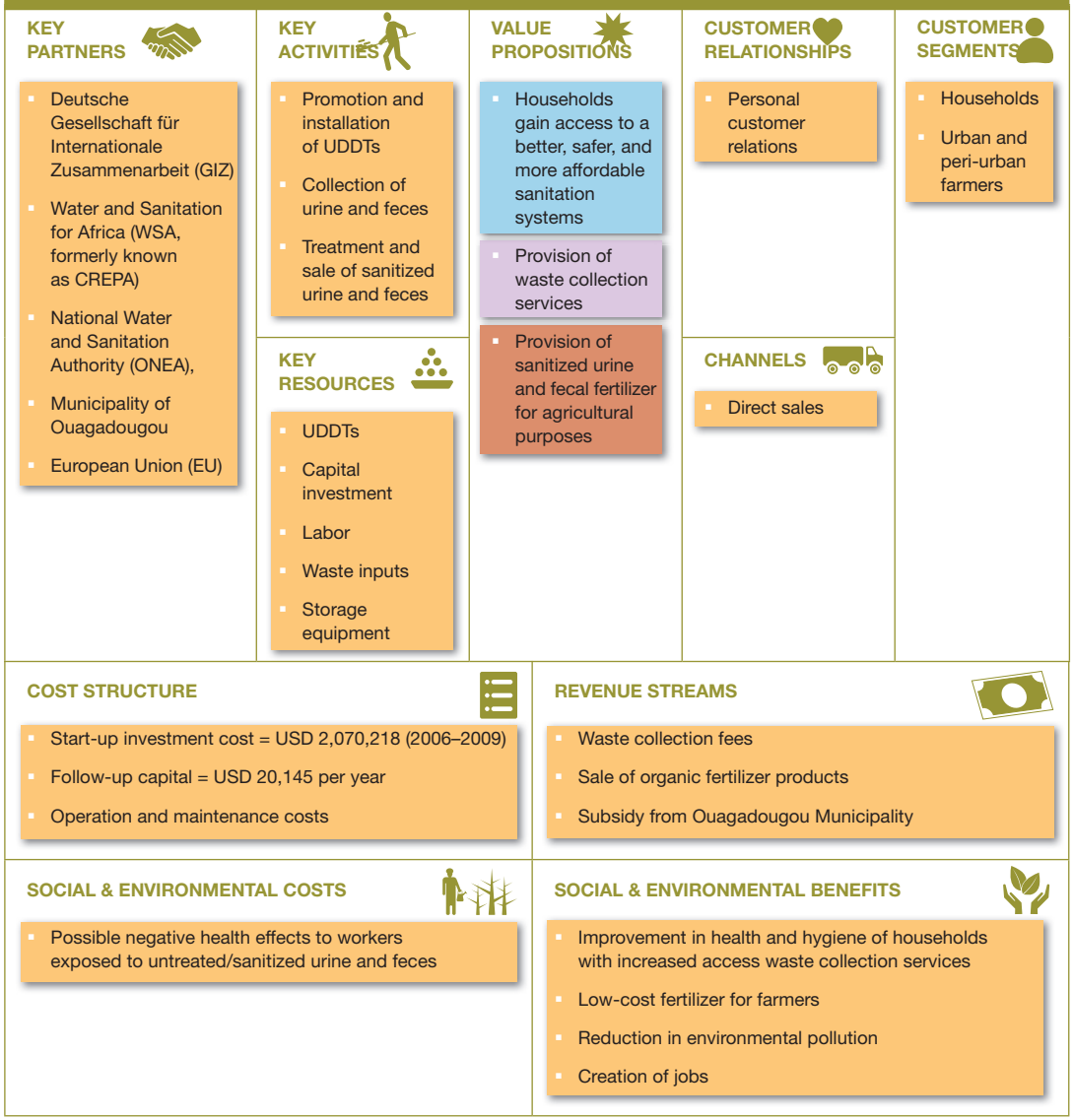
Macro-economic environment

The Government of Burkina Faso does not have an officially recognized chemical fertilizer subsidy program (IFDC, 2013). However, financial difficulties experienced by cotton companies in the country in 2005 and the food crisis of 2008 influenced the government to undertake actions to support the production of cotton and staple food crops by facilitating access to fertilizers. The goal of the fertilizer support operation in Burkina Faso was "to increase the current level of fertilizer use by reducing its cost and facilitating farmers' access to quality fertilizers". There is no prescribed fertilizer package for farmers under this program, but it covers two types of fertilizers: a combined nitrogen, phosphate and potassium (NPK) fertilizer and urea. The fertilizer support program was first introduced in 2008–2009 with exclusive funding from the national budget, and subsequently from 2010 through 2012 with support from the African Development Bank in addition to government funds. So far, the government does not have an exit strategy for the fertilizer support program. Subsidized fertilizers account for approximately 17 percent of all fertilizer products consumed in Burkina Faso. While the availability of chemical fertilizers has been enhanced, these measures will have an undesirable impact on new organic fertilizer businesses which have to compete with the subsidized market prices of chemical fertilizer. Similar incentives may be required to be put in place to enable new 'Resource Recovery and Reuse' businesses producing pelletized fecal sludge-based compost, for example, to penetrate the fertilizer market.

Business model

The ECOSAN-EU project's main goal was to facilitate access to sustainable, safe and affordable sanitation systems for the residents of Ouagadougou, support 1,000 households in obtaining appropriate and affordable closed-loop sanitation systems, provision of sanitation infrastructure (toilets) and waste collection services and contribute to food security via the conversion of human excreta into organic fertilizers for supply to local farmers (Figure 199). A notable aspect of this initiative has been the transfer of ownership to the municipality and the engagement of local community-based organizations. Although the initiative runs today as reduced level, the implementation of the initiative till this step was a success on its own. In that regard, the business model is to be viewed from the perspective of the CBO that operates, manages and owns the business entity. There are several factors that have driven

FIGURE 199. ECOSAN-EU'S BUSINESS MODEL CANVAS

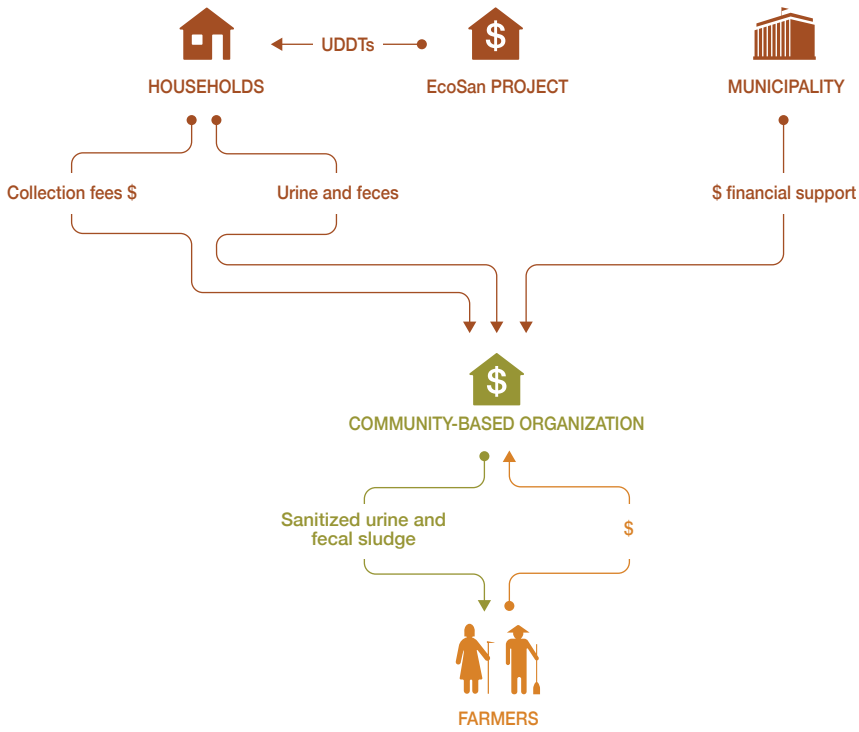


the sustainability of this initiative: a) key partnerships for financial support at the start-up stage; and b) portfolio diversification/multiple revenue streams to mitigate fluctuations in market demand of certain products and/or services (waste collection services and sale of organic fertilizers). Financial support from the municipality in the form of price subsidies on UDDTs incentivized the rapid adoption by households. This has a direct implication for the production side of the organic fertilizer products as the use of UDDTs represents easy access and availability to high quality waste inputs. With a business model that cuts across the entire sanitation value chain and also links in with the agricultural sector, the benefits from this initiative are multi-fold. The value proposition of increased access to safe and affordable sanitation systems translates into improved health of society, especially for low-income urban households in slum areas which are typically characterized by limited to no access to sanitation infrastructure and services. This notion can be extended through the second value proposition of provision of waste collection services. It is important to note that the CBOs are not directly engaged in the sale of UDDTs but the project provided subsidies to households for the construction which was done by local masons who in turn were contracted by ONEA. Benefits to the agricultural sector from the availability of organic fertilizers are noteworthy especially given the agro-ecological conditions (i.e. droughts, poor soil fertility) in Burkina Faso. Additionally, access to affordable agricultural inputs is crucial as most urban and peri-urban farmers are budget-constrained.

Value chain and position

Figure 200 below provides an overview of the value chain for a community-based organization in each urban sector. The CBO provides waste collection services to households for which it has total market control as the municipality gives them sole responsibility for this activity and thus faces no competition for provision of this service or access to the waste as an input. The CBOs in all the four sectors however noted experiencing low levels of waste supply. This has been attributed to a significant decrease (41%) in the number of households using UDDTs from 2009 to 2014 and also the supply of excreta from each household being extremely low. Only 16% of urine and 25% of feces of the expected quantity from each household was collected. Broken and non-functioning UDDTs due to rains and inundations and misinformation about collection fees led to discontinued use by households. This suggests the need for CBOs to invest in and provide repair and maintenance services for the household toilets or at the least partner with an entity to provide such services as this component of their business has significant implications for their entire business value chain. Other possible reasons include other toilet alternatives, overestimation of expected volume of excreta and open-dumping by households if collection services were irregular. Despite the fact that approximately only 1.6% of households in the four sectors were connected to the project system, the demand for the fertilizer products is fairly low as not all the produced fertilizer (both sanitized urine and feces) had been sold. The CBOs currently face stiff competition from subsidized chemical fertilizer and other factors related to stigma of using excreta-based fertilizers, strong smell of urine, transportation challenges and additional labor costs due to bulkiness of urine and feces. The businesses subsequently have rebranded their products with labelling to dispel the negative perceptions of waste-based products. Sanitized urine is sold in green 20L cans labelled “birg-koom”, which means liquid fertilizer; and sanitized dried feces are sold in bags labelled “birg-koenga” which means solid fertilizer. Field demonstrations have also been key to show the efficiency and use of the fertilizer products and this has significantly increased demand especially for the dried feces in the past year. The main clientele are farmers and nurseries, with a few large-scale buyers – plantation owners from outside Ouagadougou. From 2009–2012, 21 tons of dried feces (424 bags of 50 kg) were sold, which represents 48% of the total quantity collected. The CBOs continue to face challenges with the sale of urine – which amounted to 11,188 20L jerry cans, which represents 74% of the total quantity collected. Additional awareness programs are being planned.

FIGURE 200. ECOSAN-EU'S VALUE CHAIN



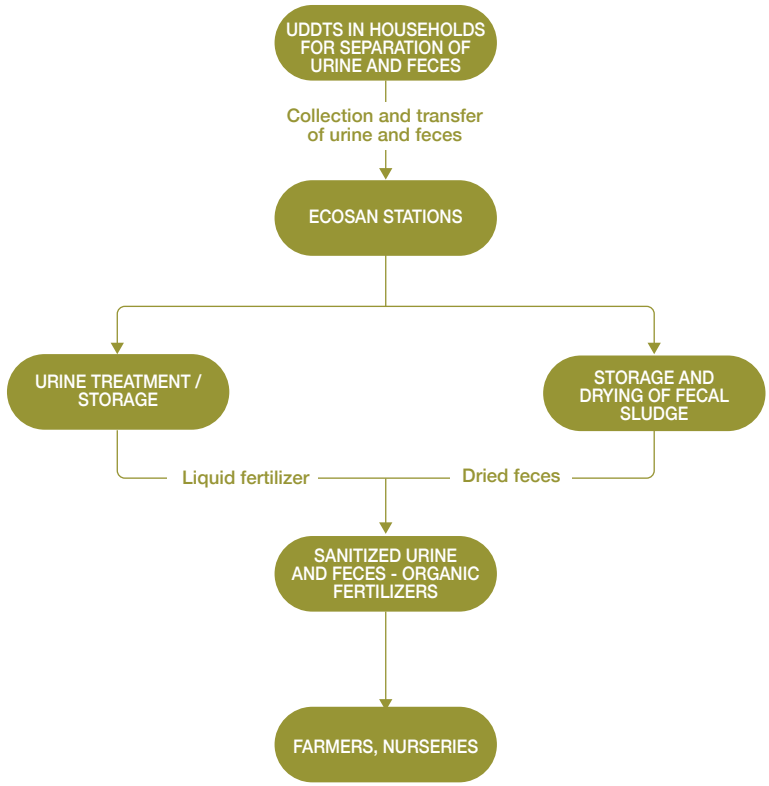
Institutional environment

The management of waste in Burkina Faso in general is dealt with under several laws and regulations. As with the CBOs, in order to legally engage in any waste management activities, a clearance must be provided by the municipality. The sole assignment of the CBOs to excreta management in the different sectors by the municipality has enabled the CBOs to ward off any competition for the provision of waste collection services but also access to the waste input. The municipality additionally provides financial support to the CBOs by paying the salaries of all staff for the four associations. Approximately, CFA 7 million (USD 14,735 – using 2014 conversion rates) is set aside annually in the municipal budget for the system.

Technology and processes

The process of production of the sanitized urine and feces is very simple and involves a low-level technology (Figure 201). There were originally three types of UDDTs used for the collection and separation of feces and urine at the household level: double-vault toilets, single-vault toilets and box toilets. Households are advised to add ash after each defecation to enhance pathogen die-off and drying. In the double vault toilet, the vaults are used in alternation and the full vault is kept closed for at least 6 months to sanitize the excreta. The vaults are then emptied by the collection service workers and brought to an eco-station for further drying and storage of at least two months before final packaging and sale. The sanitization of urine occurs once transferred to the eco-stations via storage in closed 1m^3 plastic tanks for at least one month. Feces from single vault and box UDDTs were directly collected in lined containers (using rice-bags). After the trial period, it was however

FIGURE 201. PROCESS DIAGRAM FOR PRODUCTION OF ECONSAN-EU'S SANITIZED URINE AND DRIED FECAL SLUDGE



decided that the construction of single vault/ box versions would cease due to the higher collection rates needed and challenges associated with providing adequate lining for the containers. During the period of 2006–2009, more than 300,000 litres of urine and 44,000 kg of feces in total were collected from the four sectors. This amounts to 27 20L jerry cans of urine and 80 kg of feces per household, which suggests that there are many households who are currently not using the UDDTs on a regular basis. The associations stated that collection services to households are provided on a weekly basis although cases of limited use were attributed to irregular provision of collection services and the malfunctioning of UDDTs. While this technology is simple and cost-effective for the CBO – in regards to easy access to waste inputs and income generation from waste collection, it is imperative that the CBOs pay particular attention to efficiently providing consistent collection and maintenance services.

Funding and financial outlook

Initial capital cost for the project was provided by the following institutions in the amounts of: EU = EUR1.11 million (USD 1,534,908), CREPA = EUR207,120 (USD 286,405.54) and GIZ = EUR180,000 (USD 248,904). The involvement of households in the construction process of the toilets via the provision of building materials and assistance for the construction workers significantly reduced the start-up costs. Since 2010, when the municipality took over the management role of this initiative, it invests USD 14,735 yearly in the four sector associations which cover the staff salaries for all associations.

The support the associations receive varies from USD 157.64–324.96 per month depending on size of each sector and quantity of UDDTs. Based on the information of the associations, this means a subsidy of USD 1.78 (CFA850) per household per month. There were two CBOs appointed per urban sector, and these form one association in each of the sectors to reduce management costs. The associations are trained and involved in project management and operation, which includes collection, transport, treatment, management, delivery. The expenditure of an association consists primarily of salaries, maintenance work at the eco-stations, transport and communication expenses and this amount varies from USD 277–304 per month. The monthly income for each association consists of a fixed sum of about USD 415 for associations in sectors 17 and 30, and USD 318 for associations in sectors 19 and 27. This fixed amount was taken over in 2010 by the Ouagadougou municipality after the EU project was completed. The variable income for the associations include monthly collection fees of USD 0.69 per UDDT (dependent on households that are able to pay), income from selling the EcoSan fertilizers (sanitized urine sold at USD 0.21 for 20-litre jerry can or USD 10.37/m^3, and sanitized feces at USD 5.34 for a 50kg bag). The total income received from all sectors from sales and collection fee, is about USD 451 (CFA214,400) per month and this goes toward maintenance of equipment. The income stream from current sales of sanitized urine and feces is fairly low compared to the revenue from waste collection fees at a ratio of about 70/30. The generated revenue only constitutes about 24–43% of the total revenue for the associations, with the rest been subsidies from the municipality. The associations could potentially become independent with increased demand and sales of organic fertilizers from increased product awareness, branding and product differentiation, to name a few.

Socio-economic, health and environmental impact

This initiative has had noteworthy impacts on the communities in Ouagadougou. With a business model that cuts across the entire sanitation value chain, this initiative has created jobs especially for low-income persons who would otherwise be unemployed. Additionally, smallholder farmers who are typically budget-constrained have access to comparably cheaper fertilizer alternatives. The introduction and incentives put in place to facilitate household adoption of UDDTs have significantly improved the health and hygiene of households with installed UDDTs. Communities have also noted a reduction in air pollution and flies from reduced open dumping of human excreta. In total, approximately 224,000 litres of urine were sold from 2009–2012 for all four sectors, which represent 74% of the collected urine, and 21 tons of sanitized feces sold, representing 48% of the collected feces. Another advantage from the adoption of UDDTs by households is that the monthly collection service is cheaper than having a one-off pit emptying service and the lower risk of inundation of the latter toilet types compare to the former. Households, however, tend to empty jerry cans filled with urine into street gutters and the environment if collection services are irregular. Additionally, environmental pollution could also potentially occur at the eco-stations from leakages of aging 1m^3 urine tanks or from flooding of fecal storage vaults during extreme rains, which happened in 2009.

Scalability and replicability considerations

The key drivers for the success of this initiative are:

- Strong partnerships for provision of start-up and working capital.
- Diversified portfolio – which mitigates risk associated with fluctuations in market demand for any one product or service.
- Assured supply of waste input at limited operational cost.

This initiative has a good potential for replication especially in low-income developing towns and cities with well developed urban and peri-urban market farming able to absorb the recovered resources. The strategy of close cooperation with communal authorities, community based organisations in peri-urban areas, and the local private sector was adopted throughout the project and this brought positive

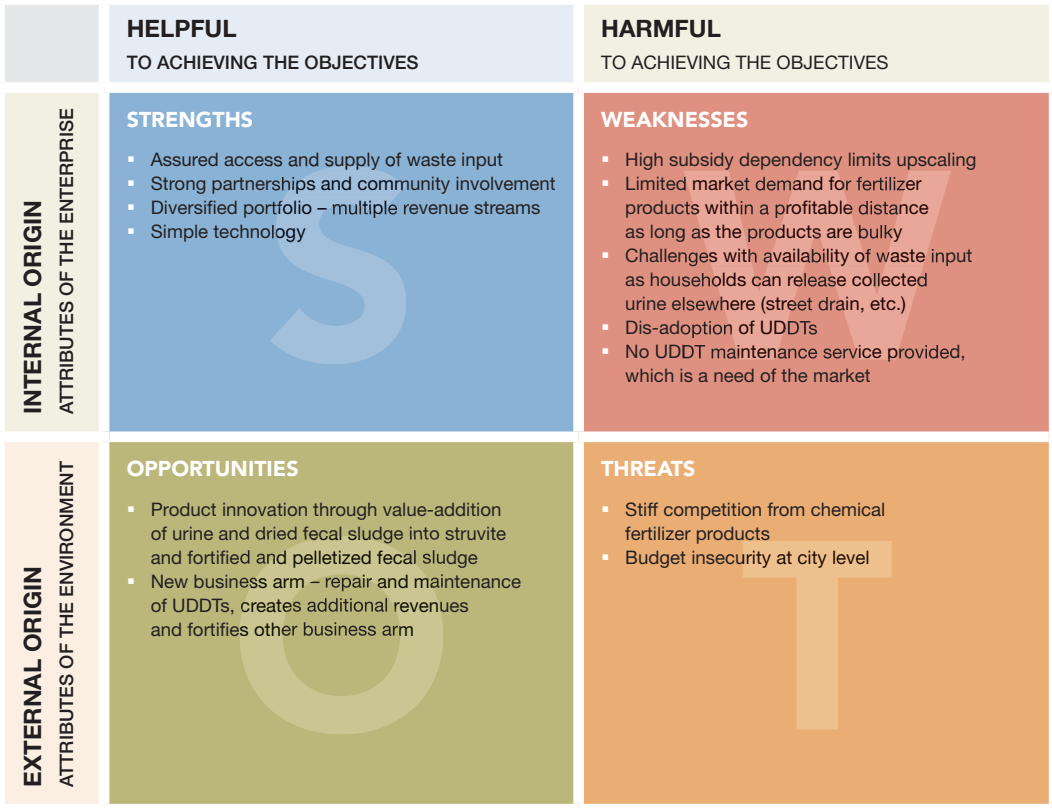
results with a high degree of engagement from all stakeholders involved. This focus has helped to increase the capacities of actors to engage in a programme of sustainable sanitation systems aiming at ensuring that activities will be integrated into ongoing work when the initial project ended – an important strategy for any plans for out-scaling. Monitoring activities throughout the project phase were an integral part of the project cycle. This allowed improving the design, mitigating construction errors, ensuring that the households maintained their new toilet facilities properly, and to encourage safe reuse practices. The study was carried out for 2.5 years after which the municipality took over. Results indicate that the number of toilets had decreased from 938 in 2009 to 551 in 2012. The drastic decrease is due to reasons such as abandonment of toilets that were broken and not functioning, destroyed latrines by rains and inundations and households not using or removing toilets as a result of misinformation about waste collection fees. This suggests the need for CBOs to invest in and provide repair and maintenance services for the infrastructure (toilets) or at the least partner with an entity to provide such services as this component of their business has significant implications for their entire business value chain. The present farming activities in the city can absorb the excreta from approximately 50,000 people, compared to 1.5 million inhabitants in Ouagadougou. Both land and water resources may limit urban agricultural expansion. Therefore, any up-scaling of reuse of sanitation products has to connect with the hinterland of the city, and in the case of Ouagadougou, applied in rain-fed farming. This requires the use of new technologies to add-value to urine and feces such as pelletized fecal sludge-based compost, which will allow businesses to increase demand by accessing new markets beyond the city limits. Product differentiation will: 1) increase the competitiveness of the products; and 2) eliminate the transportation challenges and additional labor costs associated with the bulkiness of urine and feces.

Summary assessment – SWOT analysis

Figure 202 presents an overview of the SWOT analysis for the EcoSan system in Ouagadougou. This initiative has been particularly successful in leveraging strategic partnerships to mitigate capital investment risk. The strategy of close cooperation with communal authorities, community-based organizations and the local private sector resulted in positive results with a high degree of engagement from all stakeholders involved, facilitating the transition phase from a project to a 'business'. The implementation of a multiple revenue stream strategy has been crucial in sustaining the viability of the initiative as it is noted that income generation from the sale of organic fertilizer products contributes only 30% of the overall revenue generated. One of the key weaknesses of this initiative is that it is highly subsidized, with municipal support covering 65–75% of the associations' income. The present system is not working in an optimal and efficient way, and it is clear that a subsidy that was close to CFA 10,000 per household per year would not be sustainable in the case of up scaling. In 2001 there were 154,000 households in Ouagadougou (SUSANA, 2012), which most likely is around 200,000 households today. Such a subsidy per household city wide would amount to approximately CFA 2 billion (equivalent to about Euro 3 million) per year for the municipality. There is an apparent gap in the business' value chain of activities – that is, a lack of provision of maintenance services for UDDTs and irregular waste collection services. This is negatively affecting the supply of waste inputs and directly affects profit levels. This represents an opportunity for the CBOs to invest in and provide repair and maintenance services for the UDDTs or at the least partner with an entity to provide such services as this component of their business has significant implications for their entire business value chain. The EcoSan system is also facing stiff competition from chemical fertilizers which are easily accessible and are now subsidized in Burkina Faso. Thus the sale of organic fertilizers will be difficult as long as chemical fertilizers are reasonably affordable. In the long run however, it is likely that chemical fertilizers will become more expensive as energy prices increase and resources become scarcer. On the other hand, these challenges present opportunities for the business to reinvent its product innovation and marketing strategy. Adoption of new technologies to add-value to feces such

as pelletized fecal sludge-based compost will increase the business' access to new markets beyond the city limits – reducing transportation challenges and additional labor costs due to bulkiness of feces, while supporting higher market prices for its products. Additionally, extending its business value chain to include provision of repair and maintenance services would be a new revenue source but also increase the number of households to which waste collection services can be provided and the amount of waste actually collected. This represents additional income and ensures an incremental quantity in the waste input available. The new EcoSan system in Ouagadougou is by no means ideal, but it has taken some innovative steps to go to scale in urban waste and nutrient management. Public funding is needed for investments in and control of the system and to a certain extent for running costs, at least in the short term. It is always difficult to mobilize scarce public funds but if the gain in health and environmental protection can be evaluated in addition to agricultural benefits, it can prove to be an economically sound public investment. Additionally, several opportunities exist for this initiative to become financially self-sufficient.

FIGURE 202. SWOT ANALYSIS FOR ECOSAN-EU



Update of the Ecosan system in Ouagadougou (Oct. 2017):
The international NGO Action Contre la Faim (ACF) coordinated a follow-up EU-funded project 2013–2016 in Ouagadougou to improve sanitation and hygiene in peri-urban sectors of the city. Part of the efforts included support to two of the existing CBOs involved in the EU EcoSan project. The

CBOs received help to develop business plans in addition to receiving improved equipment such as motorized tricycles for waste collection. Demonstration gardens were developed next to the eco-stations, enabling a supplementary source of income. The project subsidized 403 new urine diverting toilets (mainly constructed in 2016) and rehabilitated 37 old ones. During 2013–2016, the two supported CBOs sold 35m^3 of urine (43% of collected) and 17.5 tons of feces (86% of collected), which can be compared to the period 2009–2012 when 145m^3 urine was sold (82% of collected) and 12 tons of feces (60% of collected) in the same two sectors.

Challenges to sustain the operations remained, especially since the municipal subsidy for the CBOs was removed in 2013 during a turbulent period in the local administration while also households willingness to pay for collection decreased. Apart from variable demand of the fertilizer products, transport distances for input collection and product delivery is the main cost factor. To reduce costs, collection is today only 'on demand'. Technical innovations to transform urine, reducing volume and odor in a cost efficient way, will be necessary to sustain the business and enable further scaling in view of fertilizer demand and transport costs.

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Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments in 2014 and 2017. As business operations are dynamic data can be subject to change.

Note

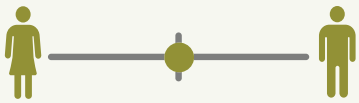
1 It is important to note that GIZ only funded the start-up of the initiative and does not have a continuous role in the business model. This is also applicable to the case of WSA (Water and Sanitation for Africa) and the EU (European Union).
2 www.iwmi.cgiar.org/tag/fortifier/ (accessed 18 January 2018).

BUSINESS MODEL 16

Phosphorus recovery from wastewater at scale

Pay Drechsel, George K. Danso and Munir A. Hanjra

Key characteristics

Model name	Phosphorus recovery from wastewater at scale
Locations	Tested so far in 14 commercial installations worldwide (status January 2017)
Waste stream	Wastewater (sewage)
Value-added waste product	Recovery of phosphorus for reuse as clean-green fertilizer with environmental benefits
Geography	Any urban centre, applicable to a wide range of sewage treatment plants
Scale of production	Medium to very large; minimum plant size of 19 MLD sewage
Supporting case in this book	None (the case of urine collection in Ouagadougou, Burkina Faso is unrelated)
Objective of entity	Cost-recovery [ ]; For profit [X]; Social enterprise [ ]
Investment cost range	USD 2–5 million with a capex pay-back time of 3 to 7 years
Organization type	Public, private
Socio-economic impact	Enhanced compliance with environmental regulations, reduction in eutrophication and environmental pollution, cost savings for municipalities, reduced damage to public/municipal infrastructure, reduced financial costs for the society and potentially cost-efficient fertilizer reuse
Gender equity	Technology-wise no particular (dis)advantage for any gender 

Business value chain

After food digestion, our ultimate 'food waste' is discharged as excreta into toilets and where toilets are connected to a sewer, sewage treatment plants become vast nutrient transformation hubs where depending on the technology significant amounts of nutrients can be extracted from the waste stream, ranging in the case of phosphorus (P) from 20% to over 80% of the P in the wastewater. The cost per unit of P recovered varies with the wastewater volume and P concentration and are significantly higher for smaller plants and for lower discharge effluent P concentrations. So far, the cost of recovered P exceeds the cost of natural rock-phosphate (Petzet and Cornel, 2013; Mayer et al., 2016) making P recovery financially not viable. As it is uncertain when rock-phosphate prices will change, and if the fertilizer industry will accept the new product[1], the double value proposition offered for example by Ostara is interesting. The Ostara technology, like similar ones, aims at P removal from the liquid generated from sludge dewatering. As the liquid (sludge liquor) feeds back into the treatment

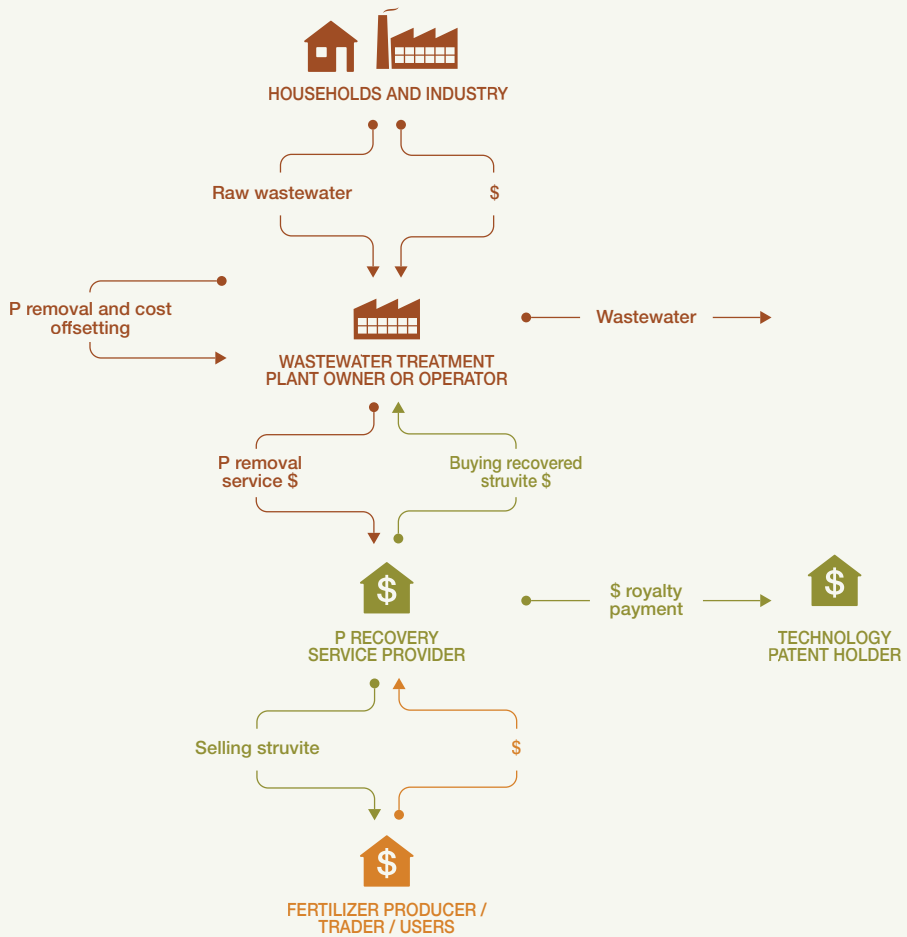
process, and contains a significant share of the overall P load, the removal of P in the return flow improves the biological nutrient removal performance of the treatment plant and prevents unplanned P crystallizing in the form of struvite[2]. The business concept is based on a PPP where Ostara is assisting the treatment provider in reducing its maintenance and disposal costs for P removal after its unplanned crystallization, while generating a high-quality slow-release fertilizer. The process offered by Ostara does not replace traditional sewage treatment, but can be (retro)fitted into the facility's existing treatment process (see http://ostara.com).

The benefits from the concept are multiple: the treatment plant saves costs, high enough to finance the investment, the captured phosphorus is of high quality (no contaminants) and can be marketed as fertilizer raw material, the functionality of the treatment plants is extended while its effluent meets (even better) environmental standards (Figure 203).

Business model

This business model has a double value proposition. The first (and most important one) offers savings in treatment maintenance through an alternative P removal process; the second, a high-quality P

FIGURE 203. VALUE CHAIN SCHEMATIC – PHOSPHORUS RECOVERY FROM SEWAGE



crystal with potential use as fertilizer. The model is as such cost-driven for utility clients, and value-driven for resource sales. There are two models for financing the capital investment required for the P removal/recovery. Ostara offers its PEARL™ process based on either a traditional **capital purchase business model**, or through a **treatment fee model**. In the treatment fee model, Ostara pays for the installation and keeps ownership while the municipality or treatment plant operator (the client) runs the nutrient recovery process. Using a long-term contract, the client pays a monthly treatment fee based on agreed performance on phosphate removal. The treatment fee is lower than the costs of conventional phosphorus removal leading to immediate savings on operational costs. In the capital purchase model, the client pays for the installation and recovers the costs through maintenance savings usually over three to seven or max. ten years.

In both models, Ostara has a multi-year **purchase agreement** with the client to buy back the generated P crystals which are technically for the treatment plant a 'waste' product, while Ostara offers struvite marketing under the brand name Crystal Green™. In other cases than Ostara, the municipality might engage itself in fertilizer sales, be it for (green) image marketing or revenues. This, however, requires additional investments to enter the fertilizer market. In the case of Ostara's PEARL™ process, the struvite is generated as a side product which gives Ostara flexibility in its pricing and makes it relatively independent from the current rock phosphate price.

In alternative processes where P is, for example, extracted from the **ash** of mono-incinerated[3] sewage sludge, the P recovery can be much larger than from sludge liquor, but does not reduce the cost for the treatment plant, and has to be largely financed through P sales unless the recovery process is subsidized due to the environmental benefits. This dependency on the global rock-P price remains a challenge for the acceptance of several P recovery technologies, and most companies target premium (niche) markets with higher than usual willingness to pay. In general, ecological and economic benefits of closed loop concepts are not (yet) the driving force for the implementation of P recovery technologies, but financial advantages.

The business model described in this chapter presumes the operation for a standalone **private enterprise** (Figure 204). A largely complementary description of the Ostara case has been provided by P-Rex (2015).

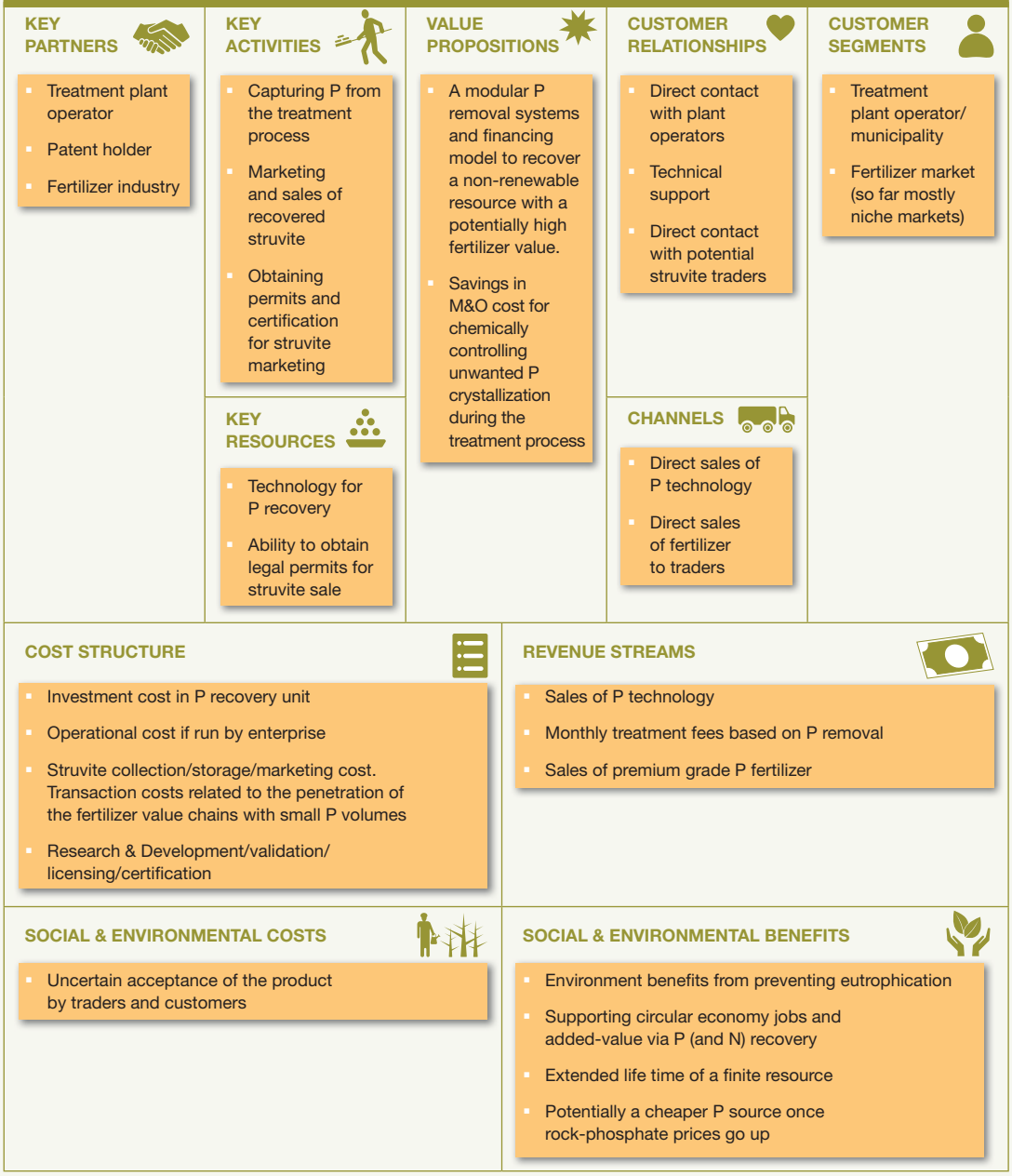
Potential risks and mitigation

Market risks: From the recovery enterprise perspective, the number of wastewater treatment plants currently being built, or already set up, without P recovery units is larger than what the suppliers of P recovery technology could satisfy. In this sense there is limited risk, especially as with increasing emphasis on the SDGs, environmental sustainability and a circular economy, the recycling market will certainly grow. There remains a risk of missing out on prestigious projects.

In view of the market for recovered P, there can be a variety of challenges which differ from country to country and are still limiting the potential of P recovery despite its obvious benefits:

1) In many countries a range of markets might not be accessible due to prohibitive legislations or missing legislation on the reuse of waste derived resources.
2) The volumes of the recovered P are still too small compared with the market size, which increases the costs of entering the current mainstream value chain.
3) Although many studies showed that recovered P crystals are of high quality, and show often even less micro contamination, e.g. with metals than natural rock phosphate, not only legislations but also the fertilizer industry is hesitant to accept the product, be it for blending of other P sources or as stand-alone slowly-soluble fertilizer.

FIGURE 204. BUSINESS MODEL CANVAS – STRUVITE RECOVERY INTO PREMIUM GRADE P FERTILIZER (OSTARA TYPE)



4) More progressive legislation in support of a circular economy could help penetrate the conventional P market by demanding for a certain ratio of recovered to natural P; an example is one of the Indian Government which requires the fertilizer industry to co-sell bags of industrial fertilizer with a number of bags of waste-based compost.
5) To avoid perception related risks, marketing strategies normally avoid any connection between the name of the P product and its source.

6) With the never-ending generation of wastewater, also the supply of recovered P will be continuous irrespective of agricultural seasons. This will pose storage challenges unless multiple market segments next to seasonal crops are available (e.g. parks and gardens, forest or fruit plantations, year-round home gardens).
7) It is a significant advantage if like in the Ostara case the cost of P recovery can be (more than) absorbed by savings in conventional P removal, as the price of rock-phosphate is still too low compared with the break even price of recovered P, pushing recovered P into premium or niche markets which are able to pay higher-than-average prices.

P recovery from wastewater should be complemented with source separation. Capturing urine for example at large point sources (e.g. festivals) for nutrient recovery gives more flexibility to balance supply and demand, requires however similar to the case above legal support to enter established markets.

Competition risks: The number of providers of P recovery technology (and related patents) is increasing, and so is the diversity of processes supporting different treatment technologies, recovered amounts of P, and scales (WERF, 2010). Several companies have moved beyond technical pilots and are now competing on the market. However, compared to conventional suppliers of wastewater treatment technology, and demand for new plants, the internationally competitive group specialized on P recovery is still small. Where the enterprise partner has obtained a license from the patent holder, it needs to be understood how stringently the license is restricting similar business and upscaling. Patenting might open business avenues, while new technologies will continue to evolve. Competition risk is highest from the conventional P market where rock-P dominates in quantity, price-wise and is favoured also in view of some physical properties. Moreover, conventional P fertilizer might be subsidised, a benefit which is not easily applicable to a waste-derived product. Over time, it is anticipated that a higher rock-P price will help to stimulate P recovery.

Technology performance risks: Most P recovery technologies on the market have been repeatedly tested and produce a high quality final products. As the recovery potential between the technologies varies significantly (see Figure 280 in chapter 19) as does the cost-effectiveness (Sartorius et al., 2012; Petzet and Cornel, 2013), the municipality has to choose the one most appropriate for its plan, be it preventing unplanned struvite crystallization and/or compliance with P recovery targets. Where urine is collected with UDDTs their maintenance requires attention. Logistical challenges for urine storage and transport could be solved through low-cost innovations in urine dehydration (e.g. Senecal and Vinneras, 2017).

Political and regulatory risks: The regulatory context is in many countries not yet supporting 'secondary' phosphorus containing fertilizers and their producers as it is often classified as waste (P-Rex, 2015). While stringent environmental regulations on the discharge of P effluents into water bodies are on the increase and provide an opportunity to promote recovery and reuse, and so do SDG 12.4 and 12.5, these regulations mostly favour P removal, but not yet recovery and reuse. In fact, in Europe, regulations on the reuse of waste derived resources, including urine and struvite, are often very restrictive (Winkler et al. 2013). On the other hand, in many developing countries, regulations and standards might be lacking which can place resource recovery and reuse in a grey area where entrepreneurs might have an easy go, but quality control and legal security remain risk factors. However, with increasing attention to the SDGs and a circular economy the situation is changing, especially in Europe (Box 6).

Social equity related risks: There are no social risks with the model or technology, unless urine diverting toilets are targeted and household urine collection which might add to the workload of those

Box 6. P-recovery regulations and obstacles in Europe

Switzerland was the first European country to make phosphorus recovery and recycling from sewage sludge and slaughterhouse waste obligatory. The new regulation entered into force on 1.1.2016 with a transition period of 10 years. Switzerland banned direct use of sewage sludge on land in 2006, so that the new regulation will lead to obligatory technical recovery and recycling in the form of inorganic P products. Swiss sludge and slaughterhouse waste together represent an annual flow of 9100t of phosphorus.

In Germany, a new sewage sludge ordinance (AbfKlärV) is expected to enter into force early 2018, making phosphorus recovery obligatory for larger sewage works within 12 years (> 100 000 p.e.) or 15 years (> 50 000 p.e.), under certain conditions. P-recovery will thus be required for around 500 sewage plants, treating around 2/3 of German sewage. Following the legislative developments in Switzerland and Germany, Austria is now also opting for mandatory P recovery from municipal sewage sludge. The draft Federal Waste Plan 2017 (Bundes-Abfallwirtschaftsplan) includes a ban of direct land application or composting for sewage sludge generated at Wastewater Treatment Plants (WWTP) with capacities of 20,000 p.e. or above within a transition phase of 10 years. Alternatively, these WWTP will have to recover the P from sludge or its ash. This regulation will cover 90% of the P contained in the Austrian municipal wastewater.

However, P recovery within a Circular Economy requires reuse. Until now, struvite recovered from wastewater is only authorised for use as a fertilizer for some producers in some countries (e.g. the Netherlands, Denmark and Japan), or only on a case-by-case (e.g. Ostara plant by plant) authorization. Even in a country like the Netherlands, approval as a fertilizer does not ensure for struvite the ***End-of-Waste*** status. End-of-waste criteria specify when certain waste ceases to be waste and obtains a status of a product (or a secondary raw material). This current lack of clarity and disparities even between EU Member States poses a significant obstacle also to investments in the technology as long as it cannot necessarily be sold in another country, because the resulting product cannot be sold as a fertilizer.

The currently (2017) discussed new EU Fertilisers Regulation will enable recycled nutrient products to be sold in any Member State, when the new Regulation comes into force. Recognised products will also be granted de-facto End-of-Waste status. Composts and digestates are already included in the proposed Regulation text, but struvite is not. The EU's Joint Research Centre (JRC) has been mandated to make an impact assessment and (if this concludes positively) to propose criteria to add struvite, biochars and ash-based recycled nutrient products to the new Regulation annexes.

Source: http://phosphorusplatform.eu/

culturally in charge of household waste and sanitation. At larger scale, mineral fertilizer recycling not only saves jobs in the long term, but also creates additional green jobs and industries. As further increases in the price of rock-phosphate (based fertilizer) will hurt poorer countries first, the suggested resource recovery options – especially those with guaranteed cost recovery – could provide a low-cost alternative.

Safety, environmental and health risks: The industrial production of struvite shows good safety records, and the final product is usually of high purity for direct application in agriculture (Table 47).

There can however be variations in the heavy metal content with some of the technologies (Egle et al., 2014). Urine-based fertilizer is P and N rich and requires as a liquid fertilizer precaution. Although urine is per se sterile, there is a limited risk if it is collected from unhealthy people or if there is cross-contamination with fecal material. A higher risk from farmers' point of view is its unpleasant smell, and high pH which can damage crops if applied undiluted or too often. Guidelines for handling urine related risks, also in farming have been presented by Richert et al. (2010) and Stenström et al. (2011).

TABLE 47. POTENTIAL HEALTH AND ENVIRONMENTAL RISK AND SUGGESTED MITIGATION MEASURES FOR BUSINESS MODEL 16

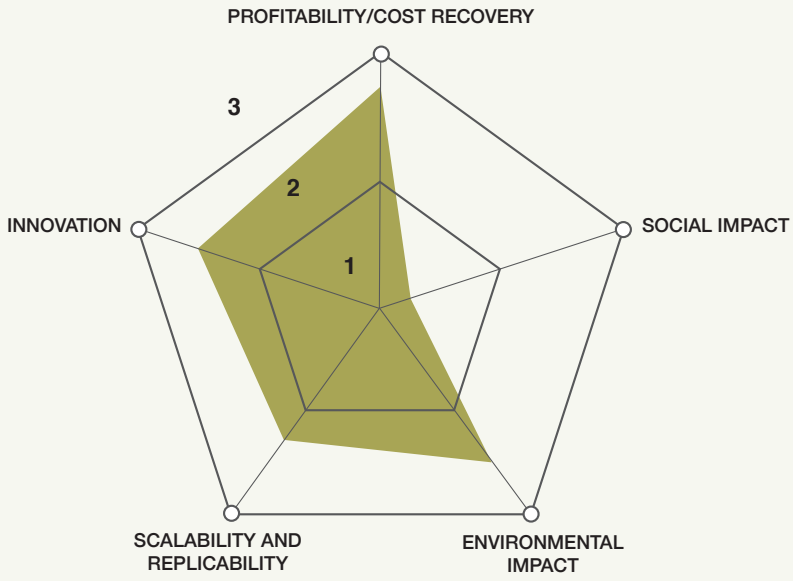
RISK GROUP	EXPOSURE					REMARKS
	DIRECT CONTACT	AIR/ ODOR	INSECTS	WATER/ SOIL	FOOD	
Worker						Independently of the struvite recovery, workers at sewage plants face the relatively highest risk
Farmer/user						
Community						
Consumer						
Mitigation measures						

Key: NOT APPLICABLE; LOW RISK; MEDIUM RISK; HIGH RISK

Business performance

P recovery technologies are on the increase. Currently, technologies with the highest economic viability for P removal during the treatment process has a cost recovery pay-back time of up to seven years. Other technologies, where P is recovered at the end of the treatment process, are financially struggling, although the P recovery percentage can be much higher. The reason is that their revenues depend – if not subsidized – on the P market price which is so far too low to compete and break even (Cornel and Schaum, 2009; Molinos-Senante et al., 2010). Thus, from the perspective of resource recovery, some of the best recovery rates are only viable when all aspects are considered, including economic, environmental and social (Balmer, 2004). In industrialized countries, a push for circular economics are expected to drive the establishment of P recovery (Sartorius et al., 2012), while the tipping point when the price of rock P exceeds the cost of P recovery remains uncertain (Horn and Sartorius, 2009). As in addition the legal framework for the reuse of resources recovered from waste remains a challenge, business models like the one of Ostara have significant advantages as their viability is independent of the P market. In general, the PPP model as run by Ostara has, except for smaller treatment plans, high replication potential. The prospects of cost recovery for the public partner and the win-win perspectives for both partners outshine the possible challenges of entering the fertilizer value chain for the generated struvite. The model ranks high on innovation, profitability and positive environmental impacts, but low on social impact (Figure 205).

FIGURE 205. RANKING RESULTS FOR A PPP MODEL IN SUPPORT OF P RECOVERY DURING WASTEWATER TREATMENT



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Case descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2014/15. As business operations are dynamic, data can be subject to change. More recently, for example, Ostara added the WASSTRIP (Waste Activated Sludge Stripping to Remove Internal Phosphorus) process to its technology solutions. See http://ostara.com/nutrient-management-solutions/.

Notes

1 Some resistance had been explained with the characteristics of recovered P crystals, like their slow solubility as well as regulatory challenges (see box 6 and chapter 19).

2 The spontaneous and unplanned formation of struvite in treatment plants affects pipes and other inner surfaces of the treatment process, making operation of the plant inefficient and costly because the struvite must be dissolved with sulphuric acid or broken down manually.

3 "Mono-incineration" means that the sewage sludge is incinerated separately, not mixed with municipal solid waste or other waste, and the ash contains high phosphorus levels (up to 7% P).