TOILET BOARD COALITION

NUTRIENT UPCYCLING

Unearthing the Potential of Faecal Sludge Compost

SANITATION ECONOMY MARKET STUDY

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2024

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Acknowledgements

TOILET BOARD COALITION

Founded in 2015, the Toilet Board Coalition accelerates business solutions to the global sanitation crisis. The Coalition facilitates vital partnerships between small and medium-sized enterprises (SMEs), corporates, NGOs, investors and governments who share a commitment to achieve access to sanitation and hygiene for all by 2030 (SDG 6).

Through its sector-leading Accelerator, the Coalition provides business model coaching, corporate mentorship and access to investment to Sanitation Economy entrepreneurs serving low-income markets. To date, the Coalition has graduated 70 SMEs, impacting more than 3 million people daily and unlocking US$33 million in finance. Its 80+ Members' diverse approach to sanitation proudly leads to essential innovation in toilet design, circular recovery of biological resources, and smart digital technologies to ensure safe and sustainable sanitation for all.

With thanks to our leaders:

Unilever · Kimberly-Clark · LIXIL · USAID FROM THE AMERICAN PEOPLE · Aqua for All

The Toilet Board Coalition and its work is made possible by the generous support of its Membership.
The contents are the responsibility of the Toilet Board Coalition and do not necessarily reflect the views of the Members and partners.

Introduction

Each adult produces roughly 130 grams of faeces and 1.4 litres of urine daily.[1] While these are natural by-products of our metabolic processes, when left unmanaged, they can serve as catalysts for waterborne disease outbreaks and pollution, posing a direct threat to humanity's wellbeing.

Nearly 3.5 billion people worldwide lack access to safely-managed sanitation services.[2] The recent WHO-UNICEF report highlights the gravity of the situation, revealing that achieving universal access to safely-managed sanitation by 2030 demands a five-fold acceleration of progress.[3] This urgency is most pronounced in Africa and Asia, where nearly 988 million and 1.9 billion respectively have no access to safe sanitation.[4]

While significant efforts are being made to provide access to toilets, the latter aspects of the sanitation value chain have not been prioritised. The mounting global population results in a simultaneous increase in the volume of faecal sludge and wastewater produced - underscoring the need for equal attention in waste treatment and reuse. The World Bank estimates that the global population will reach 8.5 billion in 2030.[5] This will translate to 1.1 million metric tons of faeces and 11.9 billion litres of urine produced daily by 2030.[6]

On a (perhaps surprisingly) related note, up to 95% of global food production depends on soil productivity and the threat to food security has intensified.[7] Unsustainable agricultural practices, coupled with the overexploitation of natural resources and a growing global population, exert increasing pressure on soils. Currently, a third of the world's soils are already in a state of degradation, with experts estimating that soil erosion alone could lead to a 10% loss in crop production by the year 2050, ultimately resulting in the loss of a staggering 68 billion tonnes of invaluable topsoil.[8]

Faecal sludge contains valuable organic matter and plant nutrients which, when safely treated, can be reused in agriculture and unlock new opportunities. Innovative business models are emerging which design faecal sludge management systems with a focus on resource recovery. Composting presents an appealing, practical and economically-viable treatment solution for faecal sludge and other organic waste with its "low-tech"

requirements and ability to recover essential nutrients. It offers a way to sanitise the sludge, extract nutrients, and reintroduce them to the soil.[9] Implementing this approach on a commercial scale could shift the current waste treatment and reuse paradigm from being a public cost to a valuable and inexhaustible agriculture input, opening alternative sustainable options for farmers and other potential end-users. This is especially valuable in areas where soil organic matter has dwindled due to poor agricultural practices or regions where fertilisers are in demand.

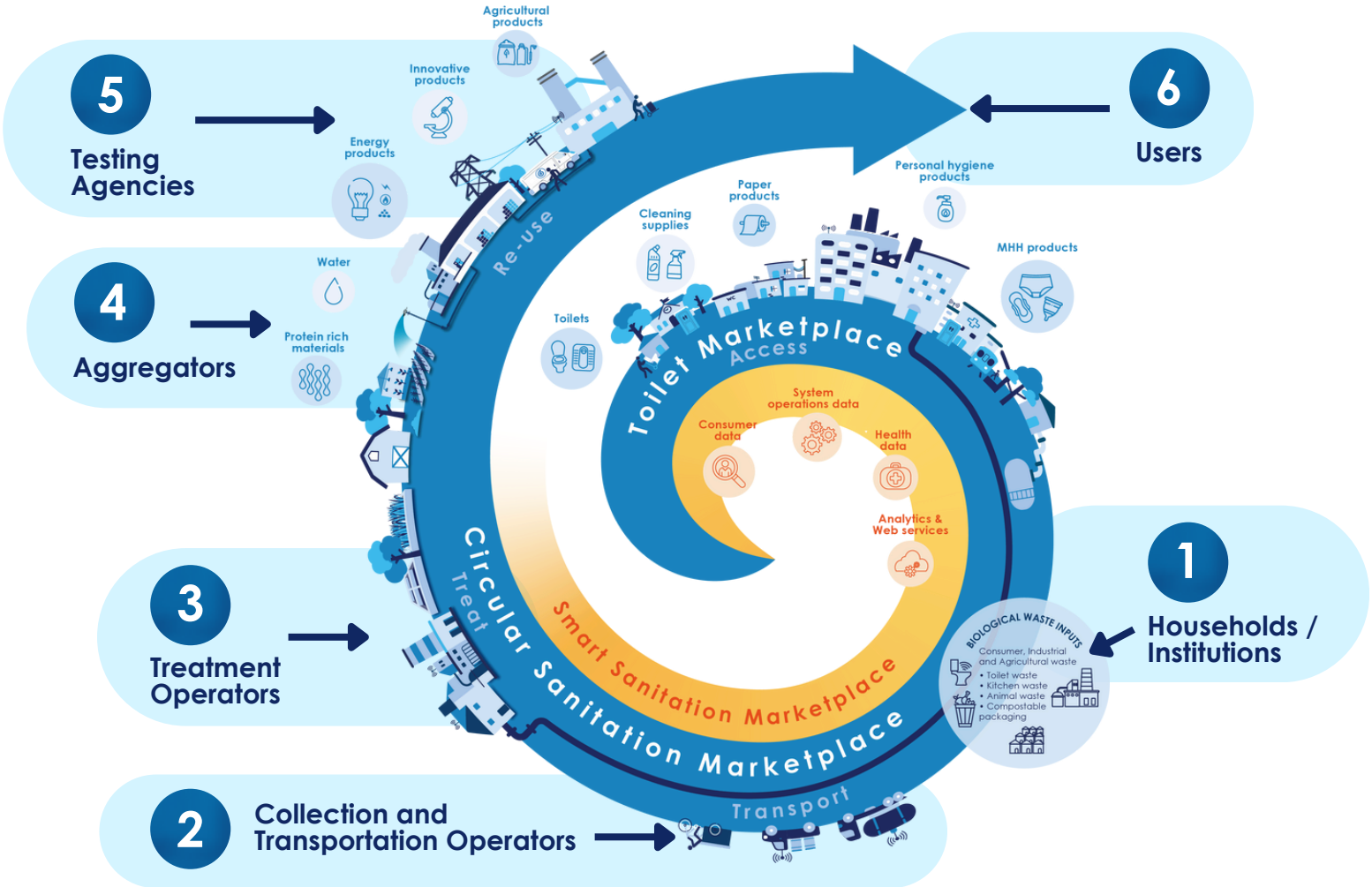
The Toilet Board Coalition, with strategic support from Aqua For All, began working with Members, alumni and partners in 2022 to understand the market potential and dynamics of faecal sludge compost (FSC). This is based on information and experiences of the Toilet Board Coalition's Accelerator alumni in Asia and Africa, who have either developed business models or are in the process of developing an additional revenue model around this market.

2. Faecal Sludge Compost Value Chain

2.1 The Production Process

Compost is a soil-like material resulting from the controlled aerobic decomposition of organic substances found in faecal sludge, either alone or with other organic wastes, to produce a valuable soil conditioner or fertiliser. There are different methods for producing faecal sludge compost (FSC), depending on geography, scale and technology. However, in general, the production of FSC involves a network of actors and processes as depicted below (Diagram 1).

Diagram 1: Waste to Compost Value Chain



As illustrated, from the households and institutions, faecal sludge is emptied/collected and transported to treatment plants. At treatment plants, the faecal sludge undergoes various stages of sludge dewatering, mixing and co-composting with other organic waste streams; until a final output product is obtained. The output product (faecal sludge compost) is brought to testing agencies for quality and safety assessment. Once it passes testing, the co-compost is either bagged and distributed to various markets or is enriched by aggregators (mostly observed in Asia) and possibly tested again before reaching the markets. The end-users, mostly farmers and urban gardeners, purchase from markets to cultivate crops and gardens. Each stage in the FSC value chain has cost implications for the business and the FSTP operator.

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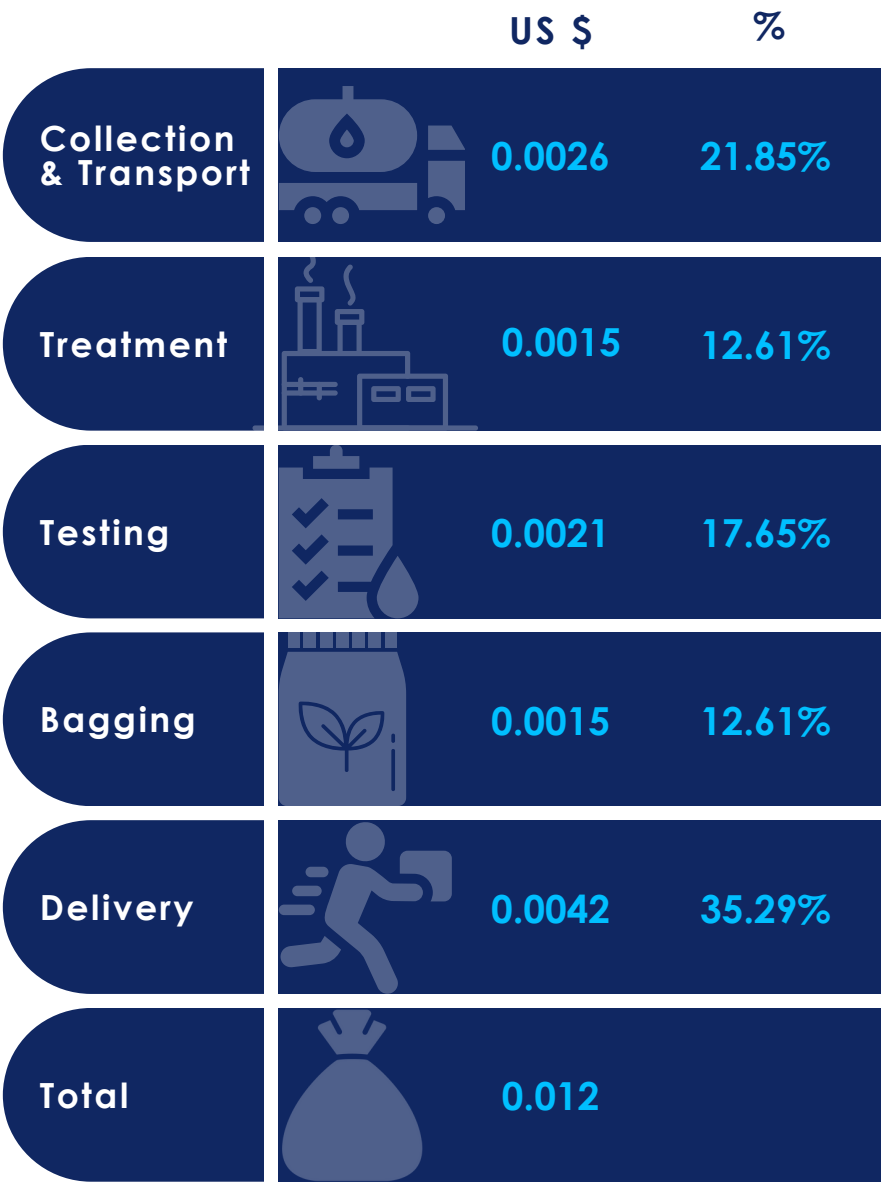
2.2 Economics

The cost of production for faecal sludge compost varies geographically. The illustration below is an example of cost breakdown of FSC in Africa, based on the data gathered from the Toilet Board Coalition Accelerator portfolio. Currently, in India, the limited quantities of FSC generated are given to farmers or government nurseries engaged in roadside plantations.

Diagram 2: Cost Breakdown of Compost in Africa



The cost breakdown shows that delivery constitutes the highest percentage (35.29%) of the total cost, followed by collection & transportation (21.85%), the actual treatment only coming third (17.65%). This highlights the opportunity for small and medium-sized enterprises (SMEs) to innovate collection, transportation and delivery. Additionally, as the market is formalised and scaled, these logistics costs will decrease due to economies of scale.

The average selling price per kg is US$ 0.06, indicating a competitive pricing structure that can support market growth and sustainability.

3. The Market

3.1 Demand

Global trends indicate that the world's expanding population, urbanisation, rising incomes and shifting lifestyles will drive a 35- 50% surge in the demand for agricultural products from 2012 to 2050.[10] In 2022, the Food and Agriculture Organization (FAO) estimated the global demand for fertilisers at around 201,000 tonnes, with significant demand found in Asia and Africa (Table 1).[11]

Table 1: Fertiliser Demand

FERTILISER DEMAND	WORLD	ASIA	AFRICA
Nitrogen	111,591	61,976	5,008
Phosphorus	49,096	27,662	2,274
Potassium	40,232	20,679	985

Source: FAO (2019)

The FAO's findings also highlight significant supply gaps in Asia and Africa, particularly in phosphoric acid and potassium for Asia, and potassium for Africa.[12]

FSC can be a strategic solution to bridge this nutrient gap. Multiple studies affirm that faecal waste is a rich source of nutrients, such as nitrogen, phosphorus and potassium. With proper treatment and handling, faecal waste can be repurposed as compost, either as a soil conditioner or fertiliser, unlocking immense market opportunities.

Toilet Board Coalition projections indicate the emergence of a multibillion-dollar market for FSC - estimated to be worth USD 2.7 billion in India,[13] USD 0.51 million in Kenya[14] and USD 2.24 million in Nigeria by 2030.[15]

Numerous companies have begun producing FSC and found success in marketing it locally. It has garnered traction from farmers in Africa, Asia and Latin America, who are enthusiastic about its use in crop cultivation due to its cost-effectiveness and greater accessibility compared to other nutrient sources.[16]

However, because of historic campaigns against illegal dumping of untreated faecal sludge, many markets face customer confusion as to the safety and value of putting these treated components on crops.

$2.7 billion
FSC Market
in India by 2030

$0.5 million
FSC Market
in Kenya by 2030

$2.2 million
FSC Market
in Nigeria by 2030

3.2 Agricultural Productivity

Research shows that recirculating nutrients from faecal waste back into agriculture significantly boosts crop production (Box A). It also conserves water, reduces herbicide and pesticide usage, and mitigates soil erosion. Critically, it facilitates carbon sequestration, both directly, through the compost material, and indirectly, through increased biomass in plant root systems.

Box A: BacTreat Environmental Solutions LLP

BacTreat Environmental Solutions LLP conducted a study in Goa, India, to explore the use of Terra Preta (TP), derived from septage sludge, in improving soil fertility. TP is a form of black soil, rich in organic matter, produced by ancient cultures through the conversion of biowaste and faecal matter. The study involved TP production using charcoal and lactic acid fermentation, followed by an evaluation of its effect on chili and paddy crops in Santa Cruz, Goa. The results showed that TP significantly increased yields for both crops (15% for chili, 16% for paddy) compared to chemical fertilisers and local farming practices. The crop quality was also comparable to chemical fertilisers, highlighting TP's potential as an environmentally-friendly alternative.

3.3 Livelihood Opportunities

The circular sanitation market - where faecal waste is collected, treated and transformed into output products like biogas, soil enhancers, protein meal, etc - presents a multitude of economic advantages. Projections show that safely-managed sanitation services generate an annual economic benefit of USD 86 billion globally, through increased productivity and reduced health costs.[17] In terms of job creation, the FSC value chain itself creates an array of employment opportunities - jobs are created in waste collection and transportation, treatment facility operations, aggregation, compost production, testing and distribution. In India alone, the full safely-managed sanitation value chain translates to 18.8 million livelihood opportunities, which can drive significant local livelihood and economic growth within the country.[18] Building upon the calculation of the livelihood potential in India, the Toilet Board Coalition conducted a projection assuming that six more countries in Asia will follow a similar trajectory as India, in terms of business appetite and government support for safely-managed sanitation.[19] **The Coalition found that 86.5 million livelihoods can be unlocked in Asia by 2030. Accordingly, we estimate that 20.8 million livelihoods can also be unlocked in sub-Saharan Africa.**[20]

86.5 million **Livelihoods** can be unlocked in Asia by 2030

20.8 million **Livelihoods** can be unlocked in sub- Saharan Africa by 2030

3.4 Greenhouse Gas (GHG) Emission Reduction

Recent research suggests that improvements in the containment, transport, treatment, and reuse of faecal sludge can contribute to reducing greenhouse gas emissions.[21] Treatment of faecal sludge via composting with other organic wastes, such as food waste, offers an environmentally-superior alternative to landfill because composting reduces methane production (a major source of greenhouse gas) and provides a series of economic and environmental benefits. A recent study by Perez et al., (2023) estimated that composting food scraps results in 38–84% fewer greenhouse gas emissions than directing them to landfills.[22]

Research has also suggested that investing in alternatives to widespread use of greenhouse gas-emitting synthetic fertilisers could go a long way to reducing overall emissions. The production and use of nitrogen fertilisers account for approximately 5% of global greenhouse gas emissions. These fertiliser gas emissions could be reduced up to approximately one-fifth of current levels by 2050 (Gao and Cabrera Serrenho, 2023) through combined interventions.[23]

Methane gas, which is the major greenhouse gas emitted from landfills, is 26 times more potent than carbon dioxide as a greenhouse gas and is a significant contributor to global greenhouse gas emissions.[24] Decomposing organic material in anaerobic conditions (which happens in the landfills) releases methane into the atmosphere. Composting is increasingly being accomplished while also capturing the methane for biogas or biomethane production. This opens up potential additional revenue streams for manufacturers through carbon credits.

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3.5 Public Health Benefits

Adoption of faecal sludge composting plants diverts pathogens in faecal sludge from human pollution pathways, thereby protecting the health and wellbeing of the general population.

Local communities would benefit from reduced contamination and waterborne diseases by diverting faecal sludge from improper disposal methods to treating by composting and then safely using FSC. Untreated faecal sludge can cause contamination of water and serves as a breeding ground for various harmful organisms and diseases, like cholera, dysentery and helminth infections - posing significant health risks.

Statistics from the World Health Organization (WHO) show that 1.4 million deaths and 74 million sicknesses could have been prevented globally with safe water, sanitation and hygiene (WASH) alone in 2019.[25] The death rate attributed to exposure to unsafe WASH services (per 100,000 population) has a global value of 18 while Africa is 47 and South-East Asia is 30.[26]

To mitigate these potential health risks, sicknesses and deaths, it is crucial to invest in appropriate treatment technologies, to eliminate or deactivate pathogens and contaminants and to actualise their full economic potential.

3.6 Market Constraints

While market potential and benefits are evident, the path to scaling contains challenges. In this section, we delve into the hurdles that confront market stakeholders.

Waste collection: this initial stage of waste collection is influenced by seasonal factors, causing fluctuations in both the quantity and quality of faecal sludge. Religious festivals and the start of the school year often lead to reduced collections, whereas the rainy season increases emptying frequency but results in lower organic loads. The quality varies based on the type of toilet emptied, with simple pit latrines containing more earth, charcoal and rubbish compared to septic tanks.

Treatment capacity: Faecal Sludge Treatment Plants (FSTPs) have limited operational capacity, particularly in urban areas, restricting the amount of treated faecal sludge. Scaling up treatment operations will require substantial investments in infrastructure, technology and human resources. Many governments in Africa and Asia are actively looking for solutions and investment to take this precise step.

Testing: the availability of testing facilities is limited, particularly in resource-constrained settings. Businesses are thus compelled to rely on foreign laboratories, incurring additional costs that can act as financial barriers for small-scale treatment operators. Additionally, the absence of well-defined standards and testing procedures exacerbates the situation. Comprehensive testing protocols can inflate expenses, discouraging the uptake of faecal sludge compost.

Distribution and sales: establishing efficient and dependable distribution networks for treated faecal sludge products can be challenging. Distribution channels, particularly for small clients, face obstacles, making direct purchase from treatment plants inaccessible. Limited capital among smallholder farmers further restricts their ability to procure the product.

These bottlenecks highlight the complexities and challenges faced. Addressing these issues is crucial for streamlining operations, reducing costs, and expanding the adoption and availability of faecal sludge compost.

4. Game-changing Impact

In recent years, significant steps have been taken towards shaping the future of faecal sludge-derived compost and the circular sanitation marketplace. In 2013, the World Health Organization marked an important milestone by releasing guidelines for the safe use of wastewater, excreta and greywater in agriculture. Fast forward to 2022: IAPMO, in collaboration with the Toilet Board Coalition, introduced the Standards on Treated FSC for Non-food Applications.

Our discussions with businesses spanning Africa and Asia have underscored the **game-changing impact of adopting well-defined standards for faecal sludge-derived compost.** This one move will set in motion a market formalisation and maturation, enabling businesses to grow and thrive.

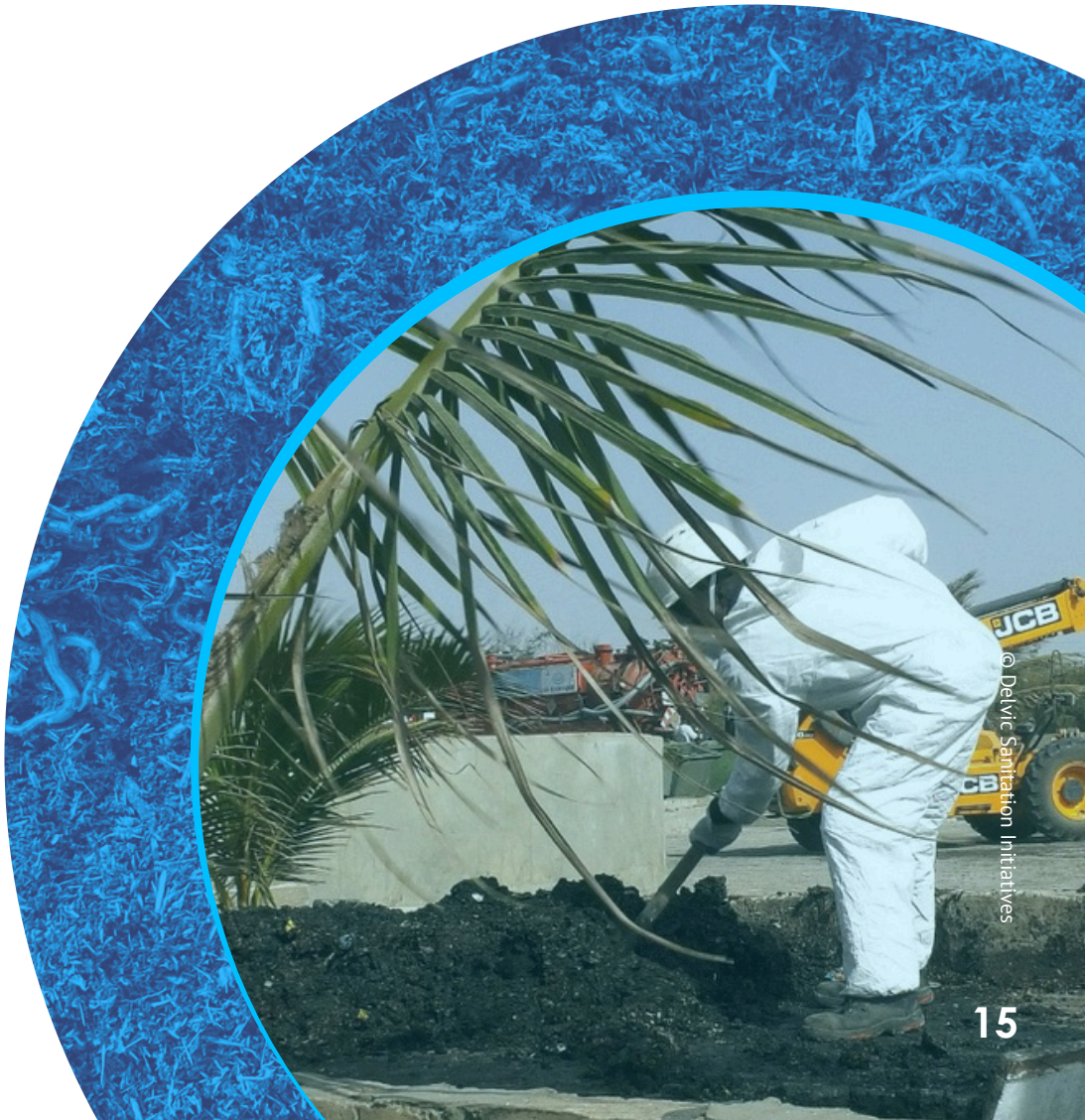
Expanding market horizons: standards serve as the bedrock upon which thriving markets for products like compost and soil enhancers are built. They instil a sense of trust and reliability among potential customers, particularly farmers and agricultural stakeholders. Businesses can approach resellers, NGOs, projects and companies with specific procurement criteria. They can also tap into emerging markets and cater to customers who prioritise quality and compliance. This expansion of the customer base, in turn, amplifies market reach and growth prospects.

Competitive edge through certification: business isn't just about meeting expectations; it's about surpassing them. In a competitive market, adhering to standards gives you an edge. Compost for agricultural use, prepared by either drying faecal sludge or co-composting with organic waste, for example, requires more rigorous checking and testing for safety. Businesses require certification to distinguish themselves from competitors and attract larger clients who specifically demand certified products.

Enhancing product value: standards elevate the product's worth and establish product safety in the eyes of customers - boosting the product's reputation and increasing customer confidence. This increased trust translates into higher demand and the ability to charge more competitive prices.

Enable government support: standards also serve to bolster government support for compost-related initiatives. Businesses can collaborate with government policies and create an enabling environment for the production and use of local organic fertilisers.

With standards in place, the stage is set for a transformative shift in the faecal sludge compost market.



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5. Call to Action

To capitalise on the powerful solution of FSC requires a collaborative effort across government, private sector, agriculture community and other stakeholders.

GOVERNMENT

- **Set quality and safety standards:** Establish clear quality and safety standards for faecal sludge-derived compost. Collaborate with experts and stakeholders to create guidelines that ensure compost is safe and beneficial for agriculture. Set up respective FSC standards to enable certification in the fertiliser market.

- **Provide incentives and subsidies:** Offer subsidy support for FSCs to reduce marketing and distribution costs, making them more accessible and affordable for end-users.

- **Create an enabling environment:** Craft special policies to allocate at least 25% of fertiliser markets to local production of organic fertilisers.

PRIVATE SECTOR

- **Partner with local government:** Engage in multi-stakeholder dialogues with government and agricultural stakeholders to ensure that the potential of products derived from faecal waste are included in conversations and policies.

- **Continue to innovate around testing technologies and transportation logistics to drive down costs:** Think creatively about testing technologies and the business models behind them. Partner bundle services and customers where possible to drive down costs of collection and distribution in the market.

- **Embrace sustainable farming practices:** Support the use of and evangelise about the benefits of FSC in improving soil quality and agricultural productivity.

CIVIL SOCIETY AND NGOS

- **Advocate and educate:** Advocate for the adoption of FSC in agriculture through awareness campaigns and educational initiatives, alleviating customer confusion. Work closely with communities and stakeholders to promote the responsible and safe use of compost.

Resources

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