

Reaching safely managed sanitation through the construction of decentralized fecal sludge treatment plants for small cities in Rwanda

By Fidele Nteziyaremye

January 2023

Background, objectives, and sanitation targets in Rwanda



Figure 1. Newly constructed decentralized fecal sludge treatment plant in Nyamagabe, Rwanda. Photo by Fidele Nteziyaremye, Dec. 2022

Rwanda has committed to ensure universal access to basic water supply and sanitation services for all Rwandans and is targeting to be amongst the first countries to achieve the Sustainable Development Goal 6 targets by 2030.

To achieve the sanitation sector goals and targets related to the increase of access to safely managed sanitation services, Rwanda has partnered with different actors to develop and implement programs and projects that contribute to improving access to sanitation services. It is in this regard that Water For People supports the government and communities to reach safely managed sanitation services through the construction of decentralized fecal sludge treatments in small cities.

According to the Rwanda Joint Monitoring Program, the concept of safely managed sanitation services is defined as the use of improved latrines facilities that are not shared with other households and where excreta are safely disposed in situ or transported and treated offsite.

Referring to 6th Rwanda Integrated Household Living Conditions Survey (EICV 6) report, only around 5.3% of the Rwandan population have access to private toilets with a solid slab, roof, door, that is safely emptied. In general, there is no centralized sewage system in Rwanda. There are 15 semi-centralized sewage treatment systems in the City of Kigali, and most households still use onsite technologies like pit latrines, dry toilets, and septic tanks, especially in urban areas.

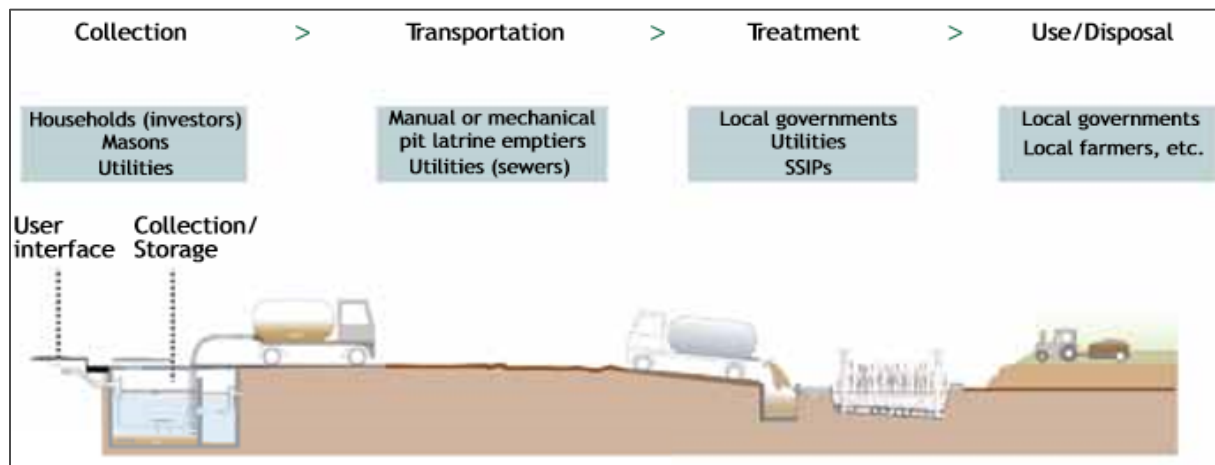


Figure 2. Sanitation value chain from fecal sludge collection to final disposal or reuse. Credit: Bill and Melinda Gates Foundation.

As shown in Figure 2 above, in semi-centralized sewage treatment systems, Fecal sludge comes from onsite sanitation technologies and is transported by truck instead of a sewer pipe. It is raw or partially digested, a slurry or semisolid, and results from the collection, storage, or treatment of combinations of excreta and black water, with or without grey water.

Safely-managed sanitation

Since 2017, Water For People has been a pioneer in the promotion of the fecal sludge management in Rwanda. Completed in 2018, the first Decentralized Fecal Sludge Treatment (DEFAST) plant was constructed in Gicumbi District with a capacity of 10 m³ per day to treat fecal sludge from Gihembe Refugee camp, Gicumbi town, and other institutions like schools, health facilities, markets and other potential public places.

In partnership with UNHCR and UNWFP and in collaboration with Nyamagabe District, in 2020 Water For people started the construction of a DEFAST plant in Nyamagabe Town. After the feasibility and design study conducted in 2020-2021, a facility with a capacity to treat 10 m³ of sludge per day with a reserve capacity of 10 m³ was constructed from June to December 2021. Now, around 90,000 households and 15,000 refugees in the Kigeme refugee camp have access to fecal sludge management services in Nyamagabe District.

Water For People has also supported Rulindo District to construct a tiger worms biofilter-based DEFAST (better known as a vermifiltration sewage treatment plant) with the capacity 10 m³ per

day. The vermifiltration plant uses tiger worms to digest the fecal sludge and turn it into harmless soil.

The facility responds to the needs of users like all public and private institutions as public places including markets in Rulindo District and surrounding areas of the region of Gakenke and Burera districts. In general, around 380,000 people are targeted for the fecal sludge management services including emptying and transport services.

Fecal sludge treatment stages

The integrated DEFAST System, which is promoted by Water For People in Rwanda, brings together various elements and factors of biological, physical and chemical treatment in a way that optimizes performance. In fact, the treatment process involves anaerobic treatment processes, algae ponds, integrated wastewater ponds and planted filtration system. All the above bring into play various chemical, biological and physical treatment mechanisms for quality effluent aiming at meeting norms and standards.

The DEFAST process consists of separation of sludge and pollutants from treated wastewater. In general, the DEFAST was developed based on the concept of low or no energy input, low-cost, and simplicity in the treatment system and operation and maintenance. Based on experience in wastewater treatment in different countries, we see that it is very difficult to treat wastewater well enough to meet all norms and standards for nutrients and microbes that contaminate surface and groundwater when discharged.

However, the DEFAST process uses anaerobic, biological, physical and chemical treatment methods to effectively process fecal sludge and reduce the risk of exceeding discharge standards.

In this context, the design scheme includes the following technologies: a bar screen, grit chamber, settling tank, anaerobic baffled reactor, anaerobic filter, aeration pond, and a planted gravel filter system. The flow rate and detention time in each DEFAST component is controlled by a valve during the treatment process.

After assessing different technologies options, DEFAST system combining the settling tank and the anaerobic-aerobic tanks with constructed wetland and drying beds is considered as the best technology. The key advantages are summarized as follows:

- There is no required energy input to run the plant because the fecal sludge flows into the system by gravity;
- If well-managed and operated, the system meets the required treatment standards;
- The system occupies a reasonable space;
- The treated fecal sludge can be turned into cooking briquettes and or bio-fertilizers and sold for added-value;
- Based on the Environmental and Social Impact Assessment (ESIA) report the technology is socially and institutionally accepted;
- Considering the investment and O&M costs, the technology is economically viable because there is also an added value from the sales of end-use products from treated fecal sludge.

Reuse of fecal sludge: the Nyamagabe DEFAST case study

The reuse of fecal sludge is one of the criteria that has motivated Water For People to promote DEFAST as the best and appropriate technology for the Rwandan context. According to the National sanitation policy and its implementation strategy of 2016, wastewater management in Rwanda has to meet the 3Rs (Reduce, Reuse and Recycle) Principle.

Considering the case study of the Nyamagabe DEFAST, the quantity of briquettes and bio-fertilizers to be potentially produced was determined based on the Total Suspended Solids generated from the treatment process. Under normal conditions, as demonstrated during the feasibility study, the treatment process could generate 40,466 kg of solids per year which are collected at the end of the process from the drying bed.

The Nyamagabe DEFAST has been managed by a private operator since May 2022. So far, around 1.5 tonnes of dried sludge have been produced. As the private operator also manages the landfill, he has an initiative to turn organic wastes into high-quality compost to sell for fertilizer. To increase the quality of the compost, the private operator mixes in the dried and treated fecal sludge at the ratio of 40%. The resulting bio fertilizer is sold at Rwf 70 per kg, which is a high enough price to incentivize the increase in DEFAST plant production.

Another use of the treated fecal sludge is the production of cooking briquettes, designed to replace charcoal in household stoves. Water For People has supplied briquette making machines and supported the construction of a kiln to carbonize the treated fecal sludge before mixing it with biomass materials like sawdust, and waste agricultural products like coffee and rice husks to form briquettes.



However, the production of fecal sludge-based cooking briquettes is still in the experimental stage and Water For People is working with the UK-Based Imperial College to ensure the briquettes produced meet quality standards. So far 1 tonne of biomass briquettes have been produced but the private operator is not yet making any with the treated fecal sludge.

Figure 3. Briquette making machine at the Nyamagabe plant (left) and the fecal sludge cooking briquettes produced (right). Photo by: [Name and date].

Lessons learned on the promotion of DEFAST in fecal sludge treatment

Since the introduction of the DEFAST technology for fecal sludge management for small cities and grouped settlements, we have experienced a number of challenges and success stories.

The DEFAST plants established are currently underused because of the limitations of emptying services. For example, the Gicumbi DEFAST was designed to serve the population of the former refugee camp of Gihembe. However, the DEFAST is highly underused because the camp's population has been moved to another area of the country and there is no reliable business that currently provides emptying services in Gicumbi. Gicumbi residents and institutions currently rely on service providers from Kigali – which makes the emptying services very expensive.

To overcome this challenge, Water For people is continuing working with the district to increase usage of the plant by mobilizing other users like secondary schools, health centers, public places like markets and rural centers by showing them the importance of emptying their toilets as opposed to backfilling or unsafe emptying practices. In order to increase the business around the DEFAST, Water For People is working with the district to develop a model where the operator may get an exclusive license to provide safe latrine emptying and solid waste management services across the town.

There is also an issue of limitation of staff capacity for the daily operation and maintenance of the plant. To solve this problem, Water For People has initiated a support and capacity development program to train private operators in the daily management of the DEFAST system.

Water For People will continue to create and promote new innovative ideas for sanitation business development, including those that promotes safely managed sanitation for the wellbeing of communities.