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FOR ALL IN A FAST CHANGING WORLD

Value from faecal sludge and municipal organic waste: fertilizer cum soil conditioner in Ghana

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Ghana is confronted with waste management challenges, with 20-40% uncollected solid waste in most cities. Also, large volumes of faecal sludge are discharged untreated into the environment. Although these wastes pose serious environmental concerns, they also contain nutrients and organic matter essential for improving soil agricultural productivity. The International Water Management Institute (IWMI), since 2001, has researched into nutrient and organic matter recovery from faecal sludge and organic solid waste in Ghana and some Asian countries such as India, Sri Lanka or Bangladesh. This has led to the production of various formulations of faecal sludge based compost (with "Fortifer" as a generic 'brand'), both in the form of pellets and powders, and specifically an ongoing project aiming at producing and commercializing the Fortifer in Ghana through a Public Private Partnership. This paper presents a summary of Fortifer technology, project objectives as well as lessons learnt during its implementation.

Background

Poor waste management with its immediate and visible impact on sanitation and the environment as a whole remains a major challenge facing cities in Ghana (Ministry of Local Government and Rural Development [MLGRD], 2010). About 20-40% of municipal solid waste (MSW) generated in the major cities remain uncollected and also there is often a direct disposal of faecal sludge (FS) into the environment, e.g. the sea for coastal towns. However, reuse of faecal sludge should be preferred to disposal as products from treated FS can generate revenues (Klingel et al., 2002). In the northern part of Ghana, there are informal arrangements between cesspit operators and farmers to discharge raw FS onto farmlands during the fallow period or dry season. The practice is popular because, compared to other areas in the country, soils are relatively low in both organic matter and nutrients as a result of bush burning, overgrazing and continuous cropping (Braimoh, 2004; Kombiok et al., 2012). Challenges associated with this practice, such as possible health risk, the bulky nature of the material and the fact that it is not permitted by law, limit the amount that can be utilized. A solution to this is to produce safe, certified and easier-to-handle fertilizer material. Over the years, IWMI has studied various technological options aimed at improving the sanitation value chain through recycling of organic solid waste and FS (Figure 1). These have resulted in the production of various forms of FS-based composts, enriched or not, both in the pelletized and powdered forms (collectively named Fortifer), for use in agriculture or as black soil.

Fortifer production process

Solids in the FS are recovered using sand filter (drying) beds and then composted or co-composted with other organic wastes such as market or household wastes and sawdust, usually for a period of 60 – 100 days. A mixing ratio of dewatered faecal sludge and municipal organic waste or sawdust at 1:3 w/w is recommended, informed by the earlier research (Cofie et al., 2009). To reduce compost application rates (volumes) and increase available N levels at the time of application, enrichment is performed, raising the compost nitrogen content from 1-2% to typically 3% through addition of e.g. inorganic N sources such as urea and ammonium sulphate. To reduce the bulkiness of composts, which is mainly responsible for most of

the difficulties associated with handling, especially storage and transport, pelletization can be done to increase bulk density by 20 – 50 %, compared to the powdered composts. Pellets are produced from composts, to which appropriate amount of water and binding material such as cassava starch are added, using a machine (pelletizer) (Nikiema et al., 2013). The Fortifer production process is shown in Figure 2.

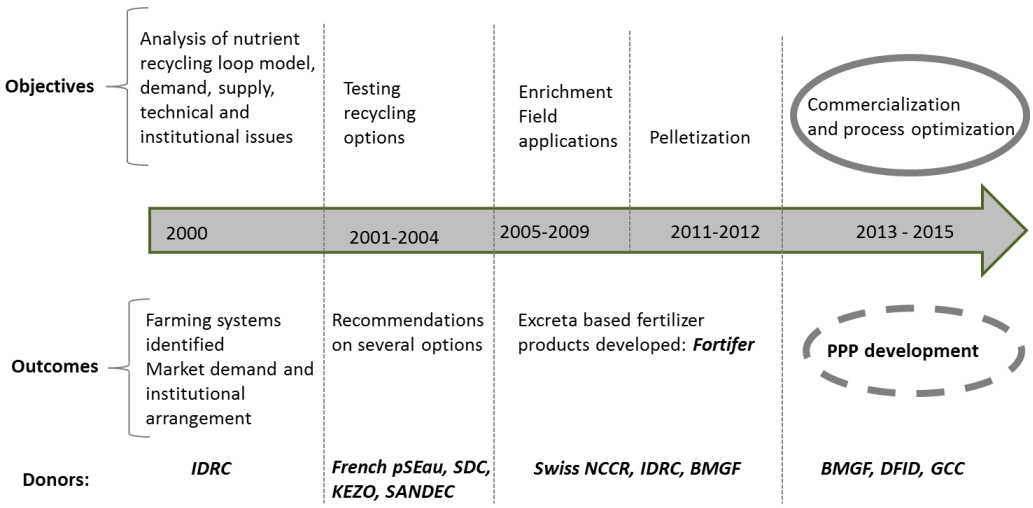

Figure 1. Evolution of Fortifer Development at IWMI

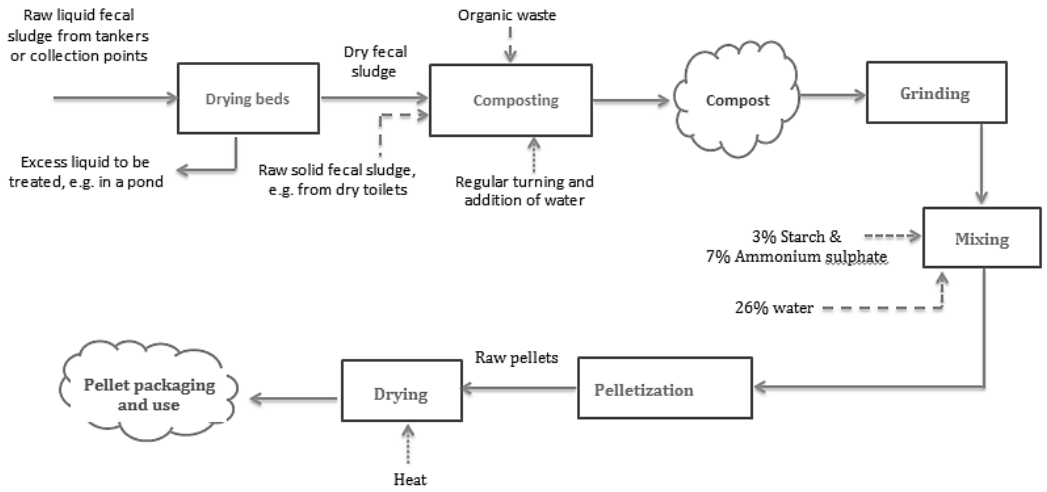

Figure 2. Fortifer Pellet production process developed by IWMI

Agronomic effectiveness of Fortifer

Both greenhouse and open field experiments have been conducted with the various formulations of Fortifer to identify best application rates on different soil types and crops. Another objective was to compare the Fortifer with conventional chemical and organic fertilizers. The chemical fertilizer used was ammonium nitrate supplemented with muriate of potash and triple super phosphate. The organic fertilizer is a plant-

based compost product (3.2% N, 3.3% P_2O_5, and 4.2% K_2O) from Eco Products Ltd. in Accra (Ghana). For example, the application of the Fortifer pellets as fertilizer resulted in high maize (*Zea mays* cv. Abeleehi) and cabbage (*Brassica olereacea* var *capitata* cv. Oxylus) yields in a greenhouse trials conducted in 2012 at Accra (Table 1).

Table 1. Effect of Fortifer pellets application (150 kg N/ha) on maize and cabbage yields (tons/ha) in greenhouse experiments

Treatments	Maize (mean ± standard error)	Cabbage (mean ± standard error)
Soil only (control)	0.9 ± 0.1	8.8 ± 0.6
EC-DFS	1.7 ± 0.2	17.3 ± 2.3
EC-SDFS	2.3 ± 0.1	16.0 ± 2.1
ECO FERTILIZER	1.2 ± 0.1	11.1 ± 0.8
INORGANIC FERTILIZER	1.7 ± 0.1	13.4 ± 0.7
Lsd (0.05)	0.3	2.3

EC-DFS: enriched compost of dewatered faecal sludge (DFS); EC-SDFS: enriched co-compost of sawdust and DFS (ratio = 3:1); ECO FERTILIZER: commercial organic fertilizer from Eco Products Ltd. Accra, Ghana; INORGANIC FERTILIZER: ammonium nitrate supplemented with muriate of potash and triple supper phosphate.

Commercialization of Fortifer and PPP

Following several research studies, IWMI has started a project in April 2013 aimed at commercial production and marketing of the Fortifer in Ghana. The overall goals that this initiative seeks to achieve include:

1. Improved soil agricultural productivity through increase in Fortifer use
2. Improved environmental management with emphasis on making a positive contribution to the sanitation value chain
3. Improved financial sustainability within the sanitation value chain, with emphasis on generation of a positive revenue stream in the long term.

As a strategy for the Fortifer commercialization a Public-Private Partnership (PPP) between a private company and the Municipality, where the Fortifer production plant will be sited, is to be formed. It is expected that the private company would serve as the Fortifer production and marketing company and also be in charge of operation and maintenance (O&M) of the Fortifer production plant while land for the facility (donor funded) will be provided by the Municipality. Figure 3 presents the PPP scenario envisioned in Ghana.

Similar IWMI projects looking at the feasibility of Fortifer production, informed by the present work in Ghana, are being under taken in different Asian countries such as India, Bangladesh and Sri Lanka (Table 3).

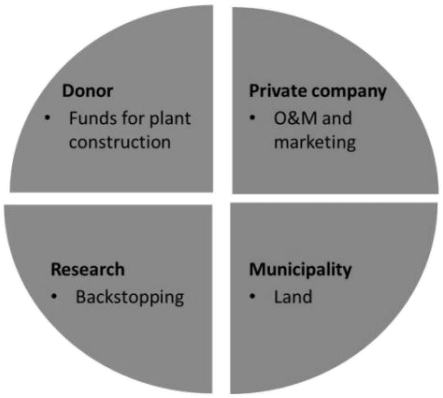

Figure 3. PPP scenario
Source: IWMI

Table 3. Description of selected IWMI reuse initiatives in Asia and Africa

	Ghana	Bangladesh	Sri Lanka	India
Organizational	Public-Private Partnership	Private enterprise and IWMI collaboration	Kurunegala Municipality, CEA and IWMI	Local University and IWMI collaboration
Faecal sludge quantity processed	About 14,000 m^3/year from households and public toilets	About 29 m^3/year from rural households with single pit latrine	About 7,300 m^3/year from households with septic tanks; about 2%-3% solid content	About 18,000 to 26,000 m^3/year from households in Rajendra nagar area in Hyderabad
Other organic solid waste	About 700 tons of organic component of municipal solid waste and saw mill dust per year at 3:1 ratio	Use of cow dung and poultry manure in 2:1 ratio with dried faecal sludge, and rice husk in 3:1 ratio	Mixed with municipal solid waste at 3:1 ratio	In design stage
Quantity of compost to be produced	500 tons per year	1.5 to 2.0 tons per year (pilot)	In design stage	In design stage
Investment items	Machinery, building construction, drying beds, composting floor	Drying bed, composting floor and shed	Drying bed, composting floor, shed and wastewater treatment plant (waste stabilization pond)	Drying bed, composting floor and shed
Land area for plant	8,000 m^2 (about 2 acres)	Approx 80 m^2 (0.02 acres)	About 1 acre	In design stage
Financial breakeven period	About 3 to 4 years	NA	NA	NA
Target market	Any cropping or non-cropping systems willing to pay			

Lessons learnt

The formation of the PPP of the current project is ongoing but already, some key lessons can be drawn.

- Identifying a suitable private partner is a very difficult exercise. Most private entities did not have experience in all relevant sectors (sanitation, marketing of agricultural products) and taking up the challenge required capacity building of their staff.
- With use of conventional means of communication (direct contacts, advertisement in newspapers or business media), expressed interest remained limited to few companies, mostly from the sanitation sector. This could be the sign for the need of better promotion mechanisms to reach other types of private companies also in the agricultural sector as these will better know the market than those engaged in waste collection.
- Given the high value and demand of land in peri-urban areas, there is significant pressure on the land resources. It was therefore observed that the public sector partner was cautious in allocating land. On the other hand, acquiring vast land (at least 1 hectare in the present case) for a project of this type without involvement of the municipality is extremely challenging because communities fear possible nuisances resulting from waste processing.
- Given the novelty of this project and its related business model and products, an advisory team, made up of experts from public and private sectors in Ghana, was formed to critically reflect on the project implementation. Their experience input allowed the project implementation team to frame the project in a way that allows its adoption. This has greatly contributed to progress made so far.
- In the course of the project implementation, it was observed that different donor-funded initiatives targeting compost or biogas production from faecal sludge were proposed in the same areas. Such situation could lead to competition for the waste and market segments which could contribute to failure of the projects.

Conclusion

The management of wastes has remained a major challenge in Ghana, particularly in major cities. Recycling of wastes for agricultural purposes could therefore contribute to sustainable improvement in sanitation and agricultural productivity. In this regard, the International Water Management Institute, based on of years of research, has developed technological options to recycle organic wastes and fecal sludge into fertilizers (Fortifer) in Ghana. In addition, there is an ongoing project to commercialize the production of the Fortifer through Public Private Partnership. This might support the generation of positive revenue stream and if replicated and up-scaled could have the potential to contribute positively to the sanitation value chain. Challenges encountered in the project implementation stage mostly have to do with limited capacity of many private entities interested in the waste reuse sector and also inadequate commitment from the public sector. Role of the donor community to start such initiatives is key as most of the resource recovery and reuse activities have positive environmental and social implications.

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