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Development of a waste stream-specific roadmap for the circular economy Zimbabwe

Activity 5.2: Pilot Business Plan. Commercial compost and organic fertilizer production facility

Date 28 April 2022

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Number of pages 20 (incl. appendices)
Number of appendices 4

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1 Background

This pilot business plan serves as deliverable for activity 5.2 and focusses on defining the pilot concept, economic activities, position in the value chain, impact, rough budget calculations, identification of potential partners and performance indicators to choose a location and partner, as well as to measure success. The pilot business plan is not a feasibility study in itself, but should be seen as a pre-feasibility study. Budget calculations are based on rough estimates to give an indication on the total costs of a pilot. No implementation party will be chosen, since this often needs to follow a strict and transparent procurement procedure. However, criteria will be defined that help guide making such a choice. The same holds for the location of the pilot, which is closely related to the chosen implementation partner. The pilot business plan will thus provide a great starting point for a feasibility study.

The pilot business plan was developed in collaboration with a Technical Committee consisting of members from various government bodies and verified with stakeholders from practice. This report documents its findings and presents the chosen pilot concept: a commercial compost and organic fertilizer production facility. The report first describes what a commercial compost and organic fertilizer production facility is (section 1), and then proposes a phased approach for implementation to spread risks and focus on viability (section 2). In section 3 the business model and some first financial calculations to assess the pilot's financial viability are presented. Section 4 discusses the impact of the pilot and section 5 presents assessment criteria to choose a location and implementation partner as well as propose performance indicators to measure the pilot's success. Lastly, section 6 gives the conclusions of the pilot business plan.

2 Description

Out of four pilot concepts, the Technical Committee choose the commercial compost and organic fertilizer production facility, as the pilot concept. A commercial compost and organic fertilizer production facility combines two type of roles: (i) compost production, and (ii) organic fertilizer production. A commercial compost and organic fertilizer production facility fulfils an essential role in the waste management system of Zimbabwe where most of the household waste (>50%) is organic, and insufficient valorisation methods exist to process the organic waste. Most organic waste is now mixed with other waste types and ends up on dumpsites where it emits greenhouse gases during decomposition and contaminates other waste streams, preventing valorisation of not only organics, but any type of waste stream.

A commercial compost and organic fertilizer production facility provides informal waste collectors, public and private collectors, and individual households with an alternative for organic waste disposal. It also offers an opportunity to provide an alternative to chemical fertilizer that is now dominant in Zimbabwe at a larger scale. Chemical fertilizer is significantly decreasing the soil quality in Zimbabwe and will lead to such a decrease in crop yields that it might damage food security on the long run.

2.1 How it works

In a commercial compost and organic fertilizer production facility, compost and fertilizer are produced from organic material on a commercial scale. Compost feeds the soil, where fertilizer feeds the plants, both are advised to stimulate crop yields. The compost and fertilizer are sold to the market as an alternative for, often imported, chemical fertilizer. The price difference between compost and fertilizer is significant with compost being much cheaper than fertilizer.

This document first describes the functions of a fully operational commercial compost and organic fertilizer production facility and then breaks it down into a phased approach for realistic implementation.

In a commercial compost and organic fertilizer production facility, separated organic household waste is collected from collectors of all levels (e.g. informal waste pickers, private collectors, small aggregators, public collectors). The commercial compost and organic fertilizer production facility then follows a process to make compost and fertilizer, the process depends on the chosen technology but roughly nine steps[1] can be distinguished:

1) **Visual Inspection:** Almost all organic waste that does not contain high toxins can be used as composting materials. However, before processing can start, metals, plastics and other unwanted materials should be removed from the organic waste stream, preferably via a conveyor belt for increased efficiency.
2) **Pre-treatment of raw materials:** To shorten compost time, the organic waste is shredded to a uniform size. To increase the quality of compost and fertilizer, a high carbon-to-nitrogen (C/N) ratio should be achieved. This can be done by mixing the household organic waste with agricultural waste such as straws and husks of grains, corn stalk or saw dust.
3) **Commercial composting:** The shredded organic waste is dumped on the ground in the form of piles with a height of between 1-3 meters. The waste should be regularly turned to ensure oxygen supply to the bacteria and ensure that all parts of the organic pile reach the required temperature of 55°C. The complete process usually takes between 4-7 weeks.

Decision Time: Compost or Fertilizer? In step 3 there are two pathways to continue. Compost Production or Fertilizer Production.

Compost Production

[1] Note that these nine steps describe a standard compost and fertilization process. A feasibility study should show if a standard process is the way to go, or that composting via black soldier flies or earthworms is a better alternative for the local context.

4) **Compost processing**: sieving the compost to get a fine product that can be easily used on the land. Larger particles can then be composted again or sold as fuel. To have optimal quality, organic compost should be dried to achieve the right amount of moist. The organic compost should thus be dried naturally or in a low-temperature oven.
5) **Packaging and sales**: the compost can then be packaged in bags of various sizes depending on the market target, e.g. big bags of 1m3 for the wholesale market.

Fertilizer Production

6) **Compost screening process**: The compost should be prepared for granulation, which requires a few activities. First, grinding to produce fine materials. Second, separation to remove larger waste such as rocks and debris.
7) **Adding organic nutrients**: To boost the nutrient content of the compost in order to make fertilizer, the compost needs to be enriched with other organic nutrients and mineral fertilizers.
8) **Drying and cooling the fertilizer**: To have optimal quality, organic fertilizer must contain a percentage of moisture. If the fertilizer is too moist, then this reduces the quality and effectiveness of the fertilizer. Therefore, the organic fertilizer should be dried, using for example low-temperature ovens, and then cooled by using a rotary cooler.
9) **Packaging and sales**: the fertilizer can then be packaged in bags of various sizes depending on the market target.

The waste that cannot be used for composting, should be brought to a waste disposal site, preferably an engineered landfill. It could also be possible to work with small scale incinerators to process the non-recyclables.
A commercial compost and organic fertilizer production facility fulfils an important role by producing a highly used product, i.e. compost and fertilizer, by using organic waste which is by far the largest stream in Zimbabwe. A visualization of the actors involved in a commercial compost and organic fertilizer production facility can be seen in Appendix A.

2.2 Benefits and challenges

The benefits of a commercial compost and organic fertilizer production facility are plentiful. It reduces the waste that ends up at legal and illegal dumpsites, which is by far the largest stream with over 50% of the mix being organics. Additionally, the potential of value retention for other waste streams such as paper, plastic, glass and metal are improved as well. Organics often contaminate other waste types, limiting their value retention potential. Emission reduction is achieved since decaying organics at disposal sites emit greenhouse gasses. Lastly, the commercial compost and organic fertilizer production facility provides the agricultural industry with a green alternative to chemical fertilizer. Substitution of chemical fertilizer will lead to environmental and social benefits, since: chemical fertilizers cause an increase in pests and kill beneficial microbes present in soil, leaching away of chemical fertilizer in groundwater contaminates the water, chemical fertilizer encourages plant disease, and long-term use will deplete the soil of essential nutrients. Many of these disadvantages are mitigated when switching to organic fertilizer.
Setting up commercial scale organic fertilizer production facility requires a solid network for collection to guarantee a sufficient and steady stream of household organic waste. Additionally, the technology needs to be adjusted to work on solid organic household waste instead of agricultural waste which is currently the case for most organic compost. For example, composting household organics might take more time or might require extensive separation to get the right mixture of organic waste to guarantee quality. Also a clear market for the products needs to be developed, where regulation and stimulation by the Ministry of Agriculture will be essential. Thus, to successfully implement organic compost on a commercial level challenges surrounding technology, infrastructure and investment need to be overcome.

A phased approach is most likely necessary to guarantee smooth adoption. For example, one can start with 50% agricultural waste and 50% solid household waste for organic compost and change the ratio slowly. Another option is to start with compost first and fertilizer later, since the first steps are quite similar, but fertilizer production requires additional steps and more advanced equipment, leading to higher investment costs.

3 Pilot Phases

To decrease the risk and costs, as well as address aforementioned challenges and give the commercial compost and organic fertilizer production facility the time to set up properly, a phased approach is proposed, as visualized in Appendix B. Each phase comes with different investment needs, partnership opportunities, levels of necessary community involvement, operational costs, challenges and revenue streams. The end goal is a production facility that produces not only compost, but also organic fertilizer at a commercial scale. However, organizing this successfully will take time, especially since large amounts of organic waste need to be collected and transported to the commercial scale compost facility. It is important that each step has a viable business model in itself and that the concept is proven before expansion towards fertilizer, which requires a lot of additional investment. Therefore, the pilot will be separated into two phases, (i) commercial compost production and (ii) expanding with fertilizer production.

3.1 Phase 1: Commercial Compost Production (0-2 years)

What?

In phase 1, the focus is on setting up an economically viable commercial compost facility. The commercial compost facility collects *separated* organic waste from the informal and formal sector. Organic waste is then aggregated, visually inspected and further separated via a conveyor belt for increased efficiency. Toxic organic materials are removed such as diseased plants, faeces, meat products or materials contaminated with chemicals. Additionally, the organic waste stream should be clean of debris and other types of waste accidently ending up in organic waste stream (such as plastics or paper). Note that separation should be done using proper protective equipment. After separation, the household organic waste should be shredded to a uniform size of between 5-10 cm to allow for efficient composting. Additionally, the household organics should be mixed with high carbon-to-nitrogen materials coming from agricultural organic waste to achieve an optimal carbon-to-nitrogen ratio of 1:30. The agricultural organic waste can be collected from markets. After pre-treatment the organic mix is divided into piles to start the composting process, which is completed after 4-7 weeks. This process does not require any special equipment, just to turn the waste every few days to allow for sufficient oxygen supply to the compost. After composting, the compost should be sieved and dried to reach the right texture and moisture levels. Then the compost can be packaged either manually or mechanically, depending on the volumes that could be achieved.

Who?

The commercial compost facility will be operated by a private company, to ensure focus on market creation, scaling and profit making. There are some parties within Zimbabwe already making organic compost, which the pilot could build upon.

There needs to be a network of collectors that bring in separated household organic waste for a fee to allow for the raw material. To encourage this, among other things, a strategic partnership should be formed with the local authorities (city council and ministry for local government). This partnership can then help with: (i) arranging land and permits, and (ii) City Council can request the separated collection of organics by their own public collectors and contracted private collectors. Note that this is not a simple task. It will require incentivizing households to separate their organics, providing them with separate bins, and requires funding for separated collection. A strategic partnership with the local authorities is therefore absolutely essential to organize sufficient volumes which are an enabling factor for the success of the pilot. Communities need to be involved in the pilot to make sure there is willingness to separate organic from other waste to allow for separated collection. Other ways of securing sufficient volumes involve buying organics from Waste Transfer Stations or Waste Disposal Centres. An advantage of this is that it would provide WTSs and WDCs with a clear outlet for their materials,

therefore stimulating them to grow. Yet another way could be to buy excess organics or organic compost from households that compost at home and involve this in the composting process.
A network of outlets needs to be established that is interested in buying the organic compost. This might be the wholesale market. However, it is important to note that there should be willingness among farmers to buy compost made from household organics. Since such compost still needs to be accepted, involvement of the Ministry of Agriculture is essential to educate farmers and raise awareness on the benefits of using such compost, as well as to guarantee quality of product, by means of certification and guidelines on nutrient levels.
There also needs to be financial support from relevant ministries. Compost made from household organic waste will most likely require financial incentives to be competitive with regular compost (from 100% agricultural waste or imported). Such financial incentives can be subsidy schemes, tax incentives, reduction of tax on products made with compost from household organics and so on.

Where?

To minimize transport distances, the commercial compost facility should be developed in an area where there are high volumes of organics and where there is already an established collection service. This makes it easier to get sufficient volumes. However, one should keep in mind that this is a commercial facility and will thus require a large area.

3.2 Phase 2: Expand Fertilizer Production (>2 years)

What?

In phase 2, the commercial compost facility will be extended to include fertilizer production. Organic fertilizer can be made by enriching compost in three additional steps, all requiring more advanced equipment. Another way to produce organic fertilizer is to work with black soldier flies or earthworms. Expansion to include fertilizer production requires quite some additional investment in equipment and labour, since three extra processing steps are necessary as visualized in Appendix A.

Who?

Expanding the commercial compost facility to include organic fertilizer production, requires some extra responsibilities of other actors and the necessity to add some actors:

- For the organization of the facility it means an expansion in terms of processes, labour, equipment, machinery and thus personnel.
- For the relationship with collectors, the partnership with government bodies and the community nothing changes.
- A new actor group that is needed is the fertilizer market. Organic fertilizer needs to be sold to customers to make a profit. Depending on the quantity of the products produced this can be directly to large scale farmers, the wholesale market, or to small scale farmers.
- Financial incentives should be implemented to make organic fertilizer competitive with chemical fertilizer

Where?

The location of the extension with organic fertilizer is the same as of the commercial compost facility. This is why it is important to have land of sufficient size to allow for expansion.

4 Business Model and Financial Plan

4.1 Business Model

This section discusses the proposed business model of a commercial scale compost and fertilizer production facility, based on the feedback of the Technical Committee members and the insights from previous activities in this project as well as various financial calculations. The business model for both phases 1 and 2 follow a standard product-based model. Compost and organic fertilizer are produced at commercial scale, and then sold to the wholesale market or directly to customers for a fixed price per bag.
The financial forecast should be perceived as a rough first order forecast, since a full feasibility study and cash-flow analysis is not part of the scope of this project. However, it is important to already make some rough calculations, to gain insights in the viability of the pilot and the volumes necessary. The pilot follows two phases: (1) the development of commercial scale compost production facility, and (2) to include the production of organic fertilizer. For both phases, the Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) are calculated.

4.2 Adopted assumptions

In financial calculations, assumptions will be used to determine the pilot's scope, the cost of investment, and revenue predictions. These assumptions will provide the basis for predicting expenditures.

- The pilot will process 1.25% of the organic household waste generated within Harare, which is equivalent to 1750 tonnes. Additionally, 1750 tonnes of agricultural waste will be used and this will be collected from markets. Thus, in total 3500 tonnes of organic waste is used for processing annually.
- The conversion rate of organics to compost is approximately 35% meaning that for the production of 350kg of compost it will require 1,000kgs of organic waste.
- The pilot will be setup close to the accumulation of waste to minimize transportation costs, since the waste is bulky.
- The pilot adopts the assumption that there will be goodwill with the local authorities, this is important is supporting the setup and ensuring a constant supply of waste, i.e. collection.
- It is anticipated that the policy environment will support the continuity of the production of compost and organic fertilizer. The country's policies will provide an enabling environment to support the pilot's sustainability and stimulate extension, as expected under the phased approach, these include tax incentives, subsidies or other financial incentives to guarantee market access.
- A realistic price for commercial compost is approximately \$30-\$50[2] per tonne to the wholesale market. The pilot will adopt a realistic price of \$40 per tonne[3]. For fertilizer a price of \$250-400 depending on the nutrient content is typical for Zimbabwe. The pilot will assume a realistic price of \$350 per tonne.
- The pilot assumes support from the Ministry of Agriculture to assist in standardization, certification and market creation.

4.3 Financial Plan for Phase 1: Commercial Compost Production

This section highlights the Capital Expenditure (CAPEX), the Operational Expenditure (OPEX) and the revenue streams, with the intent to assess the viability of the first phase of the proposed pilot.
Table 1 and 2 in Appendix C show the CAPEX and OPEX costs for the commercial compost production facility. Table 3 in Appendix C presents the revenue streams. The revenues generated by the pilot are

[2] https://www.iwmi.cgiar.org/Publications/Books/PDF/resource_recovery_from_waste-362-370.pdf
[3] https://www.thedailygardener.com/compost-price

not sufficient to sustain the pilot's operational costs. Notwithstanding, the pilot can benefit from economies of scale once the operations expand and more products are taken to the market for sale.
The social and environmental value of the pilot, might outweigh the lack of financial value. Subsidy programmes, tax incentives or EPR could assist in reaching a profitable financial flow. The probability that the pilot will be able to account for CAPEX costs, is low. Therefore, the pilot should look for external funding options, as described in section 3.5.

4.4 Financial Plan for Phase 2: Expand Fertilizer Production (>2 years)

This section highlights the Capital Expenditure (CAPEX), the Operational Expenditure (OPEX) and the revenue streams, with the intent to assess the viability of the second phase of the proposed pilot.
Table 4 and 5 in Appendix D show the CAPEX and OPEX costs for the commercial organic fertilizer production facility. Table 6 in Appendix D presents the revenue streams. The OPEX in the second phase includes the expenditure from phase 1, since fertilizer production requires the production of compost first. The calculations show that the revenues are more than the OPEX. The pilot is considered financially viable in most scenarios. However, if all costs turn out to be at the peak, the pilot lacks a bit in order to become financially viable. Note that in most scenario's the pilot can cover part of the CAPEX as well. However, external funding should still be sought after to assist in covering the CAPEX costs.

4.5 Funding Opportunities

An assessment of funding opportunities was carried out, to identify opportunities that fit the defined pilot. These opportunities are highlighted below:

Infraco - Infraco supports infrastructure projects with finance and expertise, allowing them to go from an early concept to a bankable investment possibility to a sustainable functioning business. The approach is to collaborate with projects from their early stages, either directly if they already have an experienced lead developer, or through their teams to give on-the-ground project development knowledge. Infraco also provides equity to support the building of ground-breaking projects or innovative infrastructure enterprises that need to scale up or demonstrate economic viability in order to attract more investment. Based on the financing structure, the businesses would take advantage of equity financing. This would change the business model from an envisioned public entity to a private entity.

The **Africa Enterprise Challenge Fund (AECF)** is an African development financier that promotes creative commercial ventures in order to eradicate rural poverty, establish resilient communities, and generate jobs through private sector growth. The AECF has spent over $392 million to date and offers catalytic finance and technical advising support to entrepreneurs in 26 Sub-Saharan African nations by investing in firms that struggle to fulfil commercial investors' typical risk-return guidelines.

European Investment Bank (EIB) The EIB Group provides finance and technical assistance to achieve sustainable and inclusive growth through two complementary entities, the European Investment Bank (EIB or "Bank") and the European Investment Fund (EIF). It is the European Union's long-term financing institution. EIB is exploring for project that are in line contribution to EIB's goal in reducing absolute carbon emissions by 30% by 2025. The bank has a program focusing on waste management.

5 Impact

This section will evaluate the pilot's projected impact in four areas: institutional, environmental, economic and social impact.

Areas of Impact	Description
Institutional	In order to carry out this pilot, the initiative will work with the local government. It is expected that lessons learned during implementation can be leveraged for other programmes. Collaboration with the local government and relevant ministries provides a chance to scale up the approach and contribute to waste management. The pilot's learnings can be used to improve the staff's capabilities. Bottlenecks in value chains can be identified and recommended for resolution to the appropriate ministries either through policy or institutional strengthening.
Environmental	Composting and fertilization can assist to reduce the environmental impact of incorrect waste management at open dumping or landfills. Many impoverished countries rely exclusively on open dumping or uncontrolled landfilling in their waste management operations since it is cost effective. Direct dumping of untreated organic waste has significant environmental repercussions at both the local and global levels: it results in greenhouse-gas emissions and leachate with high levels of Biochemical oxygen demand (BOD), which affect ground water and rivers if not treated properly. Inadequate organic waste management also causes fires, smells, and vermin outbreaks at disposal sites. Composting and fertilization helps to reduce or eliminate negative environmental consequences, such as odours, rodents, fires, and other risks in and around landfill sites. The amount of methane gas emitted by landfills can be lowered. Fermentation is an aerobic process that generates much less methane gas than landfilling. Organic fertilizer production can help to minimize the requirement for chemical fertilizer, which is linked to high green-house gas emissions and health concerns. Compost and fertilization has the potential to enhance soil conditions biologically, physically, and chemically, thus contributing to the realization of sustainable agriculture, which is essential for optimal crop growth. In terms of GHG potential, the reduction of GHG emissions coming from this pilot is 41 kg CO2/ton[4] of waste, pilot 3,500 ton/yr., Total emission reduction 3,500*41 kk= 143.500 kgCO2e /yr = 143,5 tCO2/yr.
Economic	Composting and fertilization at the local level might help to cut transportation and operating expenses. Composting facilities are less expensive to build and run than incineration plants. Compost and

[4] Nordahl, S. L., Devkota, J. P., Amirebrahimi, J., Smith, S. J., Breunig, H. M., Preble, C. V., ... & Scown, C. D. (2020). Life-cycle greenhouse gas emissions and human health trade-offs of organic waste management strategies. *Environmental science & technology*, *54*(15), 9200-9209.

	fertilization have the potential to improve the local agriculture, food, and tourism economies. Waste management and recycling have the potential to have a substantial influence on economic growth and job creation. The solid waste recycling industry is dynamic, yet it still offers economic opportunities with great opportunity for expansion. The waste sector is becoming increasingly significant in developing countries, as it employs a substantial proportion of the urban poor.
Social impact	Source separation and composting programs can aid in the development and enhancement of social networks, community engagement, and environmental awareness. The initiative aims to assist in the formalization of waste pickers as well as the development of jobs for women and youth. Formalization will, to some extent, create dignified jobs by creating a safe working environment. Providing an alternate source of revenue is intended to increase the waste picker's ability to spend, resulting in a ripple effect in the number of families able to support their children's education.

6 Assessment and Performance indicators

6.1 Assessment criteria for implementation partner and location

Instead of setting up a commercial compost production facility from scratch then adding organic fertilizer production, one could also work with existing organizations operating similar, but often smaller, facilities. Advantages of this are that the pilot can rely on an existing network of collectors and market outlets to buy waste from and sell compost and fertilizer to. Additionally, labour forces are already there and the organization already has a more or less sustainable business model in place. Building on an existing organization does mean that the organization chosen needs to be able to support the various phases of the pilot concept. Therefore, assessment criteria are formulated on both organization and location, to guide the decision on an implementation organization:

- Location needs to have sufficient land available to expand activities to include both commercial compost production as well as an extension to organic fertilizer production.
- Location needs to have access to electricity and water to do composting and fertilization activities on a commercial scale (e.g. separating via conveyer belt, drying via ovens, packaging).
- Location needs to be in an urban area where there is sufficient organic waste available and that is accessible for collection services (proper roads). Preferably there is already some collection in the area.
- Organization needs to have solid network of collectors and focus at least partly on organic household waste.
- Organization needs to have ties to compost and fertilizer market.

6.2 Performance indicators to track pilot success

To evaluate whether the pilot is performing as expected it is important to determine some Key Performance Indicators (KPI's). For the several processes in the pilot different KPI's are relevant. Starting with collection, it is important to keep track of the collection rate, meaning the percentage of collection compared to the estimated total waste (or in specific organic waste). This helps to get an understanding of the efficiency of collection and which potential volumes are still available. Additionally, assessing the number of collection zones and number of people for whom waste collection is available helps to get an understanding whether collection is organised properly. These indicators help to see where there is still potential to enhance collection. A gender balance KPI is important to assess the number of women that benefit from the pilot in all levels of the value chain. Additionally, the income and quality of life for waste pickers need to be included to monitor if the pilot actually stimulates better livelihoods for the upstream value chain.

Regarding processing, the processing rate or volume is a relevant KPI, just as the costs and benefits of processing. The rate or volume of processing shows the amount that is processed compared to the total amount of waste that is available. It also shows the efficiency of the processing itself and allows to identify whether there are great losses in the process. Assessing the costs and benefits of processing indicate the profitability of the process which is important to assess to sustain operation. It is also relevant to define KPI's that assess what happens to the organic waste that cannot be processed. The last dimension is the economic viability. For this the most important indicator is if the yearly revenues can cover the OPEX costs, and what margin is still left after OPEX.

7 Conclusions

This report has presented the pilot business plan: a commercial compost and organic fertilizer production facility. The pilot business plan proposed a phased approach to spread investment risks and allowing for time to set up collection and sales networks before continuing to the next.
The financial analysis for phase 1 shows that an economically viable composting facility is difficult. This is mainly due to the high costs of leasing land and the costs of buying back organics from households and private collectors. Some mitigating options to have a financially viable pilot in phase 1 would be to work with local authorities that can lease the land at very low tariffs and that can supply sufficient volumes so that organics do not have to be bought back in order to have sufficient volumes. For phase 2 the financial analysis shows that commercial organic fertilizer production is feasible; in almost all cases the OPEX costs are covered by the revenue streams.
After the pilot has been executed successfully, the pilot concept can be replicated throughout Zimbabwe. The potential to replicate throughout Zimbabwe depends on potential buyers, i.e. at this moment there is still work to be done to create awareness among farmers on the risk of chemical fertilizer and the benefits of organic fertilizer. The pilot's potential to increase the quality of life for the upstream value chain is closely related with the scale the pilot can be replicated on and the profit margin each facility can generate after scale-up. Policy reform, such as EPR or a minimum content requirement of organic fertilizer in fertilizer products, can help to replicate the pilot throughout Zimbabwe, since it will increase the demand and profit margin of organic fertilizer sales.
The first step in the roll out of such a pilot, is conducting a thorough feasibility study in which the location, implementation organization and supporting actors will be mobilized. The feasibility study should also focus on realistic volumes, setting up collection networks and forming a partnership with the local authorities to guarantee sufficient collection.

A Appendices

A.1 Appendix A – Actor overview

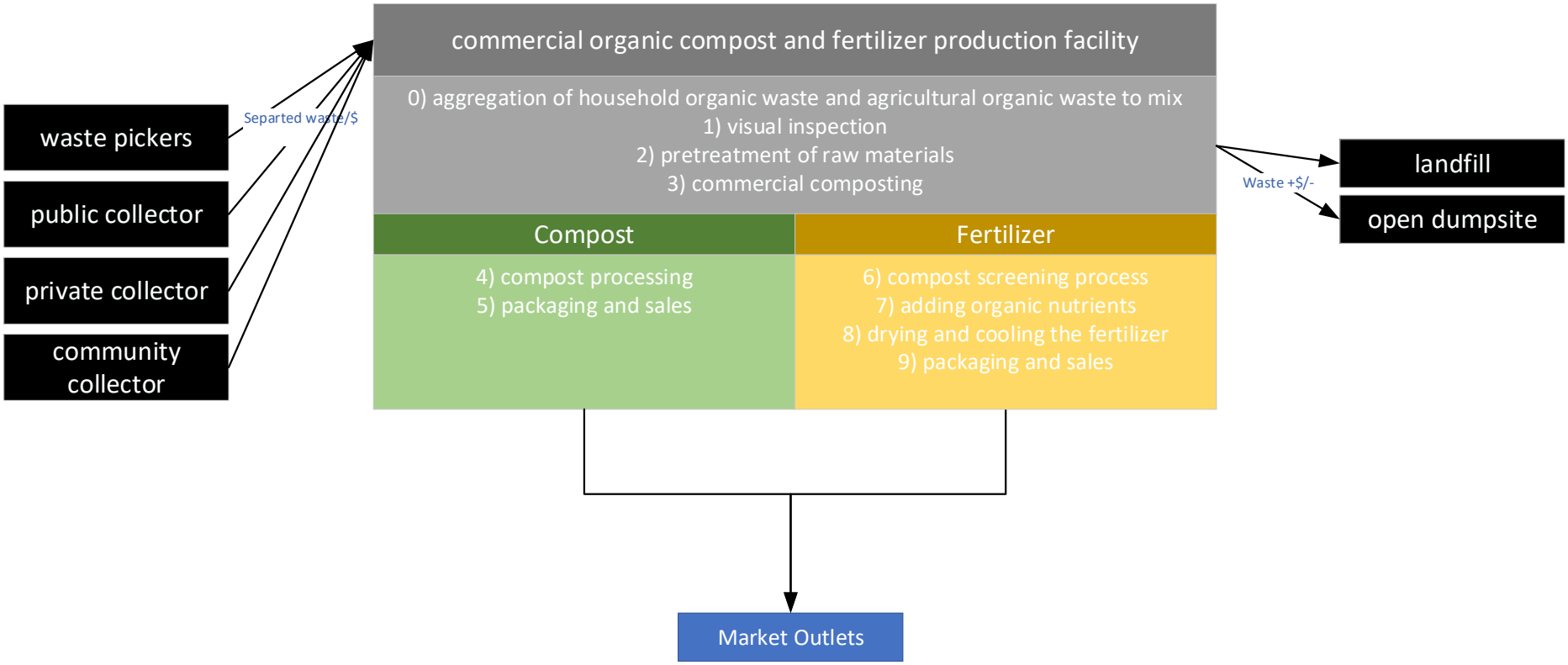

Figure 1: graphic visualization of actor network and functions of a commercial compost and organic fertilizer production facility, in red the first phase is circled.

A.2 Appendix B – Pilot phases

Phase 1: Commercial Compost Production

- organic compost is produced on a commercial scale, requiring only low-tech equipment as mentioned in steps 1-5
- organic compost is sold to the wholesale market who will target both subsistence, small and larger scale farmers as sales outlets.

Phase 2: Commercial Compost **and Fertilizer** Production

- besides organic compost production, also organic fertilizer produced
- this requires more advanced equipment and a different process, as mentioned in steps 6-9
- target markets are small, medium and large scale farmers who can afford the use of fertilizers

A.3 Appendix C – CAPEX OPEX Phase 1 Composting

TABLE 1: CAPITAL EXPENDITURES (CAPEX) FOR THE COMMERCIAL COMPOST PRODUCTION

Item	Total (USD)
Compost Tunner[5] (2)	8,200-20,000
Waste Shredder[6] (2)	8,000 - 24,000
Waste Drier	7,500-9,000
Low-cost industrial shed[7]	15,000-37,500
Composting Machine[8]	4,500-7,000
Sorting Conveyor belt[9]	5,000-10,000
Storage Facility/Office (40 ft container)[10]	3,000-4,400
Loader[11]	3,750-5,600
Ventilation System	500-600
Weighing scale[12]	229-300
50 Ton- 60 Ton Truck Scale[13]	2700-3500
Operations Vehicle (1-ton)	20,000-30,000
Office Equipment, Furniture	4,500-8,000
Total CAPEX	**82,879-159,900**

TABLE 2: OPERATIONAL EXPENDITURES (OPEX) FOR COMMERCIAL COMPOST PRODUCTION

Item	Annual Cost (USD)
Facility	
Facility, leasing of land[14] (2600sqm)	10,000-15,200
Facility costs (water, electricity, etc.) machine	3,500-5,500
Minimum Staff[15]	
Waste Control Office	4,900-5,500[16]
Machine Operators	

[5] https://www.alibaba.com/showroom/compost-turner-price.html
[66] https://www.alibaba.com/product-detail/Waste-Shredder-Shredders-Food-Kitchen-Organic_1600436094824.html?spm=a2700.galleryofferlist.normal_offer.d_title.4f484e1bAxzoP7&s=p
[7] https://www.alibaba.com/product-detail/Prefab-workshop-shed-low-cost-industrial_60707374386.html?spm=a2700.7724857.normal_offer.d_title.66651c03QDN9Wb
[8] https://www.alibaba.com/product-detail/High-Speed-Waste-Composting-Machine-Fermentation_62150535182.html?spm=a2700.wholesale.0.0.3bfc2a57TfD3sz
[9] https://www.alibaba.com/product-detail/Belt-Conveyor-Waste-Sorting-Waste-Sorting_60722643822.html?spm=a2700.galleryofferlist.normal_offer.d_title.5c652b4cUhIQD3&s=p
[10] https://www.alibaba.com/product-detail/Shenzhen-40ft-container-with-sea-freight_698203571.html?spm=a2700.details.0.0.5bc54446uxH53w
[11] https://www.alibaba.com/product-detail/China-Good-Condition-construction-machinery-0_62323174134.html?spm=a2700.wholesale.0.0.4f7e49ca4Hm7Pb
[12] https://www.alibaba.com/product-detail/1-Ton-Weighing-Scale-Hener-Manufacturer_1600469549566.html?spm=a2700.7724857.normal_offer.d_title.2ca54c755qJ0Ft&s=p
[13] https://www.alibaba.com/product-detail/Warranty-3-Years-50-Ton-60_1600459986201.html?spm=a2700.galleryofferlist.normal_offer.d_title.349278ff6Pt9DE&s=p
[14] https://www.classifieds.co.zw/zimbabwe-land-to-rent
[15] https://www.payscale.com/research/ZW/Location=Harare/Salary
[16] http://www.salaryexplorer.com/salary-survey.php?loc=243&loctype=1&job=301&jobtype=3

Operator Assistant (2)	6,000-10,000
Administrator[17]	3,500-5,500
Casuals (5)	10,000-15,000
Operations	
Machine Maintenance	3,000-4,000
Composting agent[18]	2000-3000
Large storage bags[19]	2,000-3,000
Costs of organics	8,000-10,000
Total OPEX	**52,900-76,700**

TABLE 3: REVENUE STREAMS PER ANNUM (1225 TONNES PER ANNUM)

PRODUCTS	MARKET PRICE (USD)	UNIT (TONNES)	TOTALS (USD)
Sale of Compost	40	1225	49,000
	TOTAL	**1225**	**49,000**

A.4 Appendix D – CAPEX OPEX Phase 2 Fertilizer

TABLE 4: CAPITAL EXPENDITURES (CAPEX) FOR AN ORGANIC FERTILIZER PRODUCTION FACILITY

Item	Total (USD)
Composting Machine[20]	43,000-70,000
Waste Shredder[21] (2)	7,000 - 24,000
Compost screen trommel[22] (2)	2,000-5,000
Waste Drier	7,500-9,000
Sorting Conveyor belt[23] (2)	6,000-12,000
Storage Facility/Office (40 ft container)[24] (2)	6,000-8,800
Cooler (fabricated)	2,000-3,000
Compost Fertilizer Granulator[25]	8,000-12,000
Loader[26]	3,750-5,600
Ventilation System (2)	1000-1200

[17] https://www.paylab.com/zm/salaryinfo/general-labour?lang=en

[18] https://www.alibaba.com/product-detail/Composting-agent-for-plant-growth-raw_1600251640132.html?spm=a2700.galleryofferlist.normal_offer.d_title.2a802c80l7OTsf&s=p

[19] https://www.amazon.com/Secbolt-Available-2200lbs-Duffle-Polypropylene/dp/B07D3NRSJ9?th=1

[20] https://www.alibaba.com/product-detail/Composting-Machine-Commercial-Garbage-Disposal-Food_1600449628377.html?spm=a2700.galleryofferlist.normal_offer.d_title.2d7d6e64uHGs4b&s=p

[21] https://www.alibaba.com/product-detail/Waste-Shredder-Shredders-Food-Kitchen-Organic_1600436094824.html?spm=a2700.galleryofferlist.normal_offer.d_title.4f484e1bAxzoP7&s=p

[22] https://www.alibaba.com/product-detail/Compost-Trommel-Screen-Vibration-Trommel-Drum_62074946503.html?spm=a2700.galleryofferlist.normal_offer.d_title.3ad6ff6abvhgXB&s=p

[23] https://www.alibaba.com/product-detail/Belt-Conveyor-Waste-Sorting-Waste-Sorting_60722643822.html?spm=a2700.galleryofferlist.normal_offer.d_title.5c652b4cUhlQD3&s=p

[24] https://www.alibaba.com/product-detail/Shenzhen-40ft-container-with-sea-freight_698203571.html?spm=a2700.details.0.0.5bc54446uxH53w

[25]

[26] https://www.alibaba.com/product-detail/China-Good-Condition-construction-machinery-0_62323174134.html?spm=a2700.wholesale.0.0.4f7e49ca4Hm7Pb

Weighing scale[27]	229-300
Operations Vehicle (1-ton)	20,000-30,000
Office Equipment, Furniture	4,500-8,000
Total CAPEX	**110,979-188,900**

TABLE 5: OPERATIONAL EXPENDITURES (OPEX) FOR AN ORGANIC FERTILIZER PRODUCTON FACILITY

Item	**Annual Cost (USD)**
Facility	
Facility costs (water, electricity, etc.) machine	3,500-5,500
Minimum Staff[28]	
Waste Control Office	4,900-5,500[29]
Machine Operators	
Operator Assistant (2)	6,000-10,000
Administrator[30]	3,500-5,500
Casuals (6)	12,000-18,000
Operations	
Nutrients[31]	2,000-3,000
Machine Maintenance	4,000-8,000
Large storage bags[32]	2,000-3,000
Total OPEX (2)	**35,900-55,500**
Add OPEX (1)	**52,900-76,700**
Total	**86,800-129,200**

TABLE 6: REVENUE STREAMS PER ANNUM (350[33] TONNES PER ANNUM)

PRODUCTS	**MARKET PRICE (USD)**	**UNIT (TONNES)**	**TOTALS (USD)**
Sale of Fertilizer	353[34]	350	123,550
	TOTAL	**350**	**123,550**

[27] https://www.alibaba.com/product-detail/1-Ton-Weighing-Scale-Hener-Manufacturer_1600469549566.html?spm=a2700.7724857.normal_offer.d_title.2ca54c755qJ0Ft&s=p

[28] https://www.payscale.com/research/ZW/Location=Harare/Salary

[29] http://www.salaryexplorer.com/salary-survey.php?loc=243&loctype=1&job=301&jobtype=3

[30] https://www.paylab.com/zm/salaryinfo/general-labour?lang=en

[31] https://www.alibaba.com/product-detail/Organic-Micronutrient-Seaweed-Boron-Fertilizer-ORGANIC_62359112000.html?spm=a2700.galleryofferlist.normal_offer.d_title.462818aauGwQJI&s=p

[32] https://www.amazon.com/Secbolt-Available-2200lbs-Duffle-Polypropylene/dp/B07D3NRSJ9?th=1

[33] Assumption: 40% of fertilizer is produce from processing compose

[34] https://www.iwmi.cgiar.org/Publications/Books/PDF/resource_recovery_from_waste-362-370.pdf

A.5 Appendix E - Planning

Scoping Study – April 2022	Who?
- Executed by TNO as part of the CTCN Technical Assistance. - Focused on defining a pilot business plan which is a pre-feasibility study	TNO with support from Ministry of Environment, Climate, Tourism and Hospitality Industry
Tender Process – May-September 2022	**Who?**
- Choosing implementation partners and a location for feasibility study. - Resources mobilization for carrying out of feasibility study - Develop TOR's for consultants - Tender should focus on a consortium consisting of an implementing organization for the commercial scale compost and organic fertilizer production facility that adheres to the criteria in section 5.1, and a committed city council that has the capacity and willingness to support a pilot in terms of land availability, permits and improving collection infrastructure. Based on insights scoping study.	Ministry of Lands, Agriculture, Fisheries, Water and Rural Development and Ministry of Environment, Climate, Tourism and Hospitality Industry and/or
Feasibility Study – November 2022-March 2023	**Who?**
- Focus on defining targeted communities, realistic volumes, setting up a collection network and a network of market actors interested in the products (including farmers – the end customers) - Focus on which business models are best suited for the targeted community and location to guarantee volumes for input - Identify and start collaborating with other value chain actors that will be critical during implementation - Develop detailed plan for phased roll out of pilot building on the existing scoping study	Consultant supported by implementation consortium and relevant ministries Ministry of Lands, Agriculture, Fisheries, Water and Rural Development and Ministry of Environment, Climate, Tourism and Hospitality Industry
Implementation – From April 2023	**Who?**
- Implementation in phases, following the feasibility study	Implementation consortium, with support from relevant ministries such as Ministry of Lands, Agriculture, Fisheries, Water and Rural Development, Ministry of Environment, Climate, Tourism, and Hospitality Industry,