Year One Progress Report for Sue White Fund for Africa (SWF)

Transformation of solid and liquid wastes into fertilizer to minimize urban catchment pollution

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Background

Sub-Saharan Africa (SSA) is experiencing rapid population growth that is outpacing sanitation infrastructure development and service delivery especially in urban catchment areas. In Ghana, improved sanitation coverage is only 14% and about 47% of households dispose their greywater in street gutters, which drains to pollute water bodies. Only 16% of the 74 wastewater and faecal sludge (FS) treatment facilities in Ghana are functional while some 27% are not able to treat the waste to a level that render it safe for public health prior to discharge into the environment. Similarly, solid waste is poorly managed. The release of both solid and liquid waste into the environment is leading to increasing freshwater pollution and other sanitation related health risks, and accelerating sedimentation in water bodies reducing their effective carrying capacities to absorb urban run-off and storm water.

There is therefore the need to look at alternative and appropriate solutions to these challenges. One of the solutions include nutrient, organic matter and water recovery from urban wastes to prevent nutrient run-off, catchment pollution and to divert pathogens from contamination pathways thereby enhancing recovery and reuse of useful resources. The International Water Management Institute (IWMI) has converted urban solid (food waste, FW) and liquid wastes (FS) through co-composting into various faecal derived fertilizer materials for use in urban and peri-urban crop production.

Some strides have been made in developing the faecal derived fertilizer product and commercializing it, however there are still some research and knowledge gaps that need to be addressed to optimize the processes. Identified research/knowledge gaps include limited information on the nutrient and pathogen flow (including antimicrobial resistance) in the composting system.

The overall aim of this study is to investigate how a solid and liquid waste composting system and the associated compost fertilizer product contribute to safe crop production and how these activities impact on the environment. The specific objectives are:

1. To characterize nutrient flow in a FS and food waste (FW) composting system – understanding their kinetics to aid composting and/or reduce presence of nutrients in effluents from treatment plants.

2. To assess microbial (bacteria and helminths) dynamics and prevalence of antimicrobial resistant pathogens at various stages of FS and FW compost production to storage.

3. To determine the microbial load and nutrient content of the faecal derived fertilizer at various stages/age of storage.

4. To characterize soil biodiversity, organic matter and other contaminants (pathogens, metals, antimicrobial resistance) dynamics and quantify nutrient uptake characteristics after applying stored faecal derived fertilizer.

The objectives of this project align well with the SWF mandate of furthering research into water and sanitation in Africa especially protecting catchment areas and contributing to the welfare of people. Objectives 1 and 2 are addressing the environmental pollution and inadequate sanitation arising from improper management and treatment of wastes such as faecal sludge and organic fractions of municipal solid wastes in local communities of Africa. It is expected that, these objectives will benefit the local community by minimizing run-off of nutrients into freshwater bodies in target catchments by recovering nutrients from wastes, improving overall community health and reduction in sanitation related diseases by eliminating pathogens from contamination pathways and providing cleaner environment for the local community to thrive in. Objectives 3 and 4 are addressing consumer food safety and food security issues as well as improving soil fertility and crop yields of local smallholder farmers. The key challenge being addressed by these objectives is how the use of faecal derived fertilisers can not only improve soil fertility but also meet food security of the local community. Smallholder farmers can benefit from more affordable sources of fertilisers such as this, which is expected to lead to increased farm productivity, which could lead to better nutrition and food security for the local community, increased productivity means more profits, improved livelihood, economic growth as well as job creation in local economies

Progress to date

My first year activities comprised of meeting my PhD academic requirements for year 1 (induction, initial progress review, attending courses and training and first year progress review) and unpacking the elements of my project. I have been sourcing relevant literature, sourcing suitable laboratories for analyses in Ghana (Africa), sourcing the feedstock and setting up an experiment design.

1. Sourcing relevant literature and stakeholders interview

As part of ensuring the characteristics of faecal derived fertilizer is comparable to internationally acceptable standards, I undertook a literature search on sources of certification bodies for international certification of organic fertilizers.

I have also reviewed the historical data on faecal derived fertilizer characteristics and found out that:

- There was lack of data/information on certain characteristics such as Cr IV, Cr, Hg and Ni
- Generally, historical characteristics were not meeting organic certification standards

These identified gaps are being complemented by my present study. In addition, the overall literatures review document is being worked on.

2. Sourcing suitable laboratories for sample analyses

The under listed laboratories have been identified and sourced for the analyses of samples collected. These laboratories are each responsible for specific type of analyses.

Laboratory	Type of analyses
IWMI Laboratory	- Bacteria and Helminth identification and quantification. - In-situ testing of pH, temperature and conductivity
Noguchi Memorial Institute for Medical Research (NMIMR) - UG	Antimicrobial resistance (AMR) analysis, COVID-19
CSIR - Soil Research Institute	Physico-chemical analyses: - Nutrient determination - Trace elements

3. Sourcing feedstock and setting up experiment design

The main feedstock for the project is the FS. This is being obtained from pre-treatment processes. I am currently undertaking the raw FS pre-treatment process of dewatering using sand drying beds at the SafiSana Pilot Site in Accra (Plate 1 – 3). The other feedstock which is FW is obtained from Jekora Ventures Ltd. (JVL's) source separation operations in major markets and in some institutions within their waste management operational zones. The fraction of FW collected include source-separated fruit waste (, vegetable waste and foodstuff waste The FW is further sorted out at the composting plant to remove other foreign (mostly inorganic materials) that may have been missed in the initial primary segregation. About 99% quality of FW source – separation is achieved.

Plate 1. Raw FS loaded onto a drying bed at the SafiSana pilot site

Plate 2. Almost dewatered FS (DFS) on the drying bed

Plate 3.Researcher harvesting DFS from the drying bed

A field experimental design was set up to achieve objective 3 and part of objective 1 and 2 and one experimental compost heap has already been formed and monitored (Plate 4). The additional heaps will be formed once the feedstock are acquired.

Plate 4. An experimental compost heap from DFS and FW set up

Challenges encountered

1. Covid-19 pandemic

The COVID-19 pandemic has affected some aspects of my project work. This was because of travel restrictions and lockdown imposed by the government of Ghana. I could not set up field experiments in time for data collection to begin. However, this situation has also opened new opportunities to analyse COVID-19 on the samples, as there are potential linkages of COVID-19 with Sanitation and wastewater. NMIMR lab is already a leading lab on the COVID-19 analyses in Ghana and they have been already sourced for analysis on this project. This is a new opportunity that had not been considered before but there is a potential to get new data and information on COVID-19.

2. Difficulties with obtaining faecal sludge and the field site

I faced challenges in obtaining faecal sludge as the original option available at first JVL site in Accra was affected due to a ban on site access for trucks to bring in the sludge. I had to resort to an alternative site (SafiSana pilot site) within Accra and started sorting out the infrastructure and logistics to obtain dried faecal sludge (DFS). It has been quite challenging to get the required quantities of the dewatered FS as the beds are quite small compared to JVL site and so it is taking extra longer to dewater all the material required. While this was in progress, IWMI was constructing another faecal derived fertilizer plant in another city (Somanya, ca 80 km from Accra) to be managed by JVL. The major construction is done now and IWMI is in the process of test running the plant to ensure it was ready. We have decided to use the newly constructed plant in place of the first JVL site in Accra. Though this new facility promises access to faecal sludge, there is the element of increased transportation cost which had not been budgeted for moving between Somanya and the labs in Accra.

Extra funding

We got some additional Global Challenge Research Fund QR funding to do some additional analysis on faecal derived fertilizer characteristics. This will provide some initial steps towards getting data to obtain international organic input certification.

Potential impact on community and my career

In Ghana, for example, an additional 168,600 MT of nutrients per year are required to meet the growth targets for all major crops identified in the country's Agriculture Sector Investment Plan. Meanwhile, a huge quantity of nutrients available in FS is lost. If more of these nutrients were utilised in faecal derived fertilizer production, then Ghana would need far less chemical fertilizer to meet major crop needs. The unit cost of faecal derived fertilizer is ca 50% cheaper than chemical fertilisers and it could even be cheaper over long-term applications. However, its use and benefits can only be optimised if it can be used by farmers with greater confidence in terms of its efficacy as a nutrient source and its safety from microbial perspective. The current study is amalgamating this evidence to optimise its use by smallholder farmers and improve soil fertility. The evidence once obtained will initially be shared with Jekora Ventures Ltd to aid in their product communication and marketing. The evidence will also be communicated to smallholder farmers and related stakeholders through workshops and farmer field schools in collaboration with Extension Services Department of the Ministry of Food and Agriculture. The evidence will also be shared with Non-governmental organisations, charities, SMEs and other allied organizations that operate in Ghana.

There is a better understanding of the nutrient and microbial flows in large scale FS composting schemes which could serve as a decision support tool (simulation models) to forecast valuable resources (nutrients, organic matter) that can be harvested from wastes at city scale to prevent pollution of waterways. This has the direct impact of improved public health of the community and cleaner environment. New opportunities have arisen to analyse for COVID-19 in the current study, which will contribute new knowledge.

The support, SWF has given me is an enormous boost to my career, as it puts me a step closer to my long-term career goal of contributing to improved integrated waste management linked to soil fertility improvement and improvement of sanitation in Africa or Asia. I am gaining relevant knowledge and skills on this PhD that is opening up opportunities for interactions with other research institutes and industry partners, which would be relevant professional network capital for my future career. I am hoping to be a researcher based in Ghana or in Africa where the results of my research will contribute to cleaner cities through improved sanitation linked to resource recovery and reuse as well as soil fertility improvement using locally available organic materials.