Maximising the value of human waste derived fertiliser in Madagascar

Berta Moya Diaz-Aguado, Ruben Sakrabani, Alison Parker

School of Energy, Environment and Agrifood
r.sakrabani@cranfield.ac.uk
Many modern agricultural soils are significantly degraded\textsuperscript{1}

- Increased requirements for food
- Increase in Inorganic Fertilisers
- Higher Crop Productivity
- Reduction in Nutrient Retention
- Reduction in SOM

2. UN (2004). World Population To 2300. Report by Department of Economic and Social Affairs
Project Scope

Aim
To investigate the feasibility of full nutrient recycling of human wastes into soil by producing a soil conditioner and fertiliser that is attractive to the local area where it is produced.

Objectives

• **Characterising the nutrient content** of 3 different types of soil amendments derived from human waste, namely pasteurised digestate from anaerobic digestion of the waste, compost and vermicompost from AD digestate and straw

• **Demonstrate fertiliser potential** of human waste derived materials in pot and field scale crop trials

• **Optimising the nutrient content** of fertiliser obtained from human waste as well as its commercial value.

• Identify the optimal **commercialisation channels** for fertiliser and develop business models for commercialising human waste fertiliser
• A UK-based young SME that has developed a dry toilet with associated waste treatment system.
• Pilot system in place in Madagascar
• Sale of fertiliser product to close the loop and as an additional revenue stream
### Nutrient characteristics

#### Loowatt faecal treatment system

- **Fresh excreta**
- **Anaerobic mesophilic co-digestion**
- **Digestate**
- **Thermophilic Composting**
- **Compost (C)**
- **Vermicomposting**
- **Vermicompost (V)**

#### Legend:
- **Feedstock**
- **Process**

#### Table:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean for C.</th>
<th>Mean for V.</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>8.7</td>
<td>6.9</td>
</tr>
<tr>
<td>Ammonium NH-NH₄ (mg/Kg)</td>
<td>210</td>
<td>32</td>
</tr>
<tr>
<td>Nitrate N-NO₃ (mg/Kg)</td>
<td>7</td>
<td>977</td>
</tr>
<tr>
<td>Total Nitrogen (g/Kg)</td>
<td>23.2 (2.32%)</td>
<td>10.5 (1.05%)</td>
</tr>
<tr>
<td>Organic Carbon (g/Kg)</td>
<td>393</td>
<td>175</td>
</tr>
<tr>
<td>Exchangeable K (mg/Kg)</td>
<td>26 397 (2.64%)</td>
<td>5 080 (0.51%)</td>
</tr>
<tr>
<td>Exchangeable Ca (mg/Kg)</td>
<td>349</td>
<td>881</td>
</tr>
<tr>
<td>Exchangeable Mg (mg/Kg)</td>
<td>252</td>
<td>946</td>
</tr>
<tr>
<td>Exchangeable Mn (mg/Kg)</td>
<td>6.6</td>
<td>6.6</td>
</tr>
<tr>
<td>Exchangeable Zn (mg/Kg)</td>
<td>3.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Assimilable P (mg/Kg)</td>
<td>21 (0.002%)</td>
<td>212 (0.021%)</td>
</tr>
<tr>
<td>C/N ratio</td>
<td>17</td>
<td>16.6</td>
</tr>
</tbody>
</table>
Pilot study site in Antananarivo, Madagascar

(Cranfield University)
Proposed activities during PhD

PILOT SCALE IN MADAGASCAR
- Test crops: Maize and Tomato
- Randomised complete block design with 3 repetitions
- 5 fertiliser rates

GLASSHOUSE TRIALS AT CRANFIELD
- Imported soil from Madagascar
- Test crops: Maize and Tomato
- 8 fertiliser types
- 5 fertiliser rates
FULL SCALE FIELD TRIALS IN MADAGASCAR

• Test crops: To be decided but will include rice
• Randomised complete block design with 3 repetitions
• Selected fertiliser options for optimum growth

BUSINESS MODEL

• Map current fertiliser market supply chain
• Interview of target groups – farmers, fertiliser distributors, local government representatives
• Focus group
• Survey
Project deliverables

Yield response from pilot, pot and full scale trials

NPK and how available are they to crops.
SWOT analysis

**S**
- Conversion of waste to resource
- Reducing dependence on chemical fertilisers
- Improves soil health and increase organic matter
- Provides NPK and other micronutrients
- Can address sanitation issues – better health and well being

**W**
- New product
- Perception of farmers and end-users
- Efficacy in supporting crop yield

**O**
- Income generation for farmers – business model
- Fertiliser supply chain – focus group study

**T**
- Feedstock used in composting has to be adaptable to availability of supply
- This will influence quality of final fertiliser