Case study of sustainable sanitation projects

Household composting of organic waste and faeces Kitgum Town, Uganda

Fig. 1: Project location

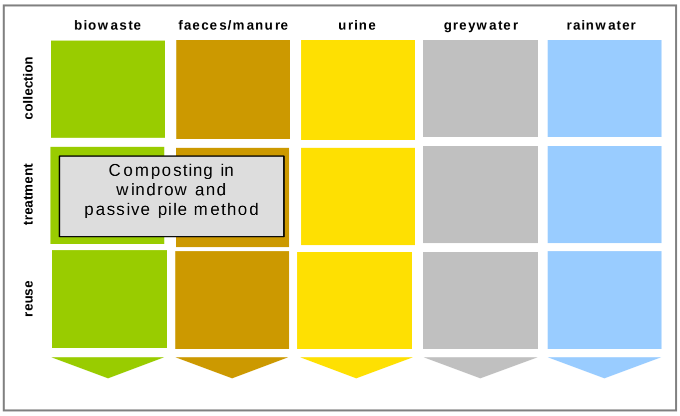

Fig. 2: Applied sanitation components in this project

1 General data

Type of project:
Pilot scale construction of household based composting units

Project period:
Start of construction: April 2009
End of construction: June 2009
Start of operation: September 2009
Ongoing monitoring period planned for: until March 2010
Project end: March 2010

Project scale:
Number of inhabitants covered: 50 people (9 households)
Total investment: EUR 90 for 9 compost piles (future costs may be much lower according to type of composting, see also Section 9).

Address of project location:
Kitgum Town council, Uganda

Planning institution:
ROSA – Uganda: Kitgum Town Council, Makerere University and EcoSan Club, Austria

Executing institution:
Kitgum Town Council

Supporting agency:
European Union

The work was carried out within the project ROSA (*Resource-Oriented Sanitation concepts for peri-urban areas in Africa*; Contract No. 037025-GOCE; duration: 1.10.2006 – 31.3.2010), a Specific Target REsearch Project (STREP) funded within the EU 6th Framework Programme, Sub-priority "Global Change and Ecosystems".

2 Objective and motivation of the project

The overall objectives of the project were:

1. to contribute to the current efforts for promoting resource-oriented sanitation concepts as a route to sustainable sanitation and to fulfil the UN MDGs,
2. to research the gaps for the implementation of resource-oriented sanitation concepts in peri-urban areas,
3. to develop a generally applicable adaptable framework for the development of participatory strategic sanitation & waste plans (SSWPs), and
4. to implement resource-oriented sanitation concepts in four pilot cities in East Africa (Arba Minch, Ethiopia; Nakuru, Kenya; Arusha, Tanzania; and Kitgum, Uganda).

Specific objectives include

- Using composting in order to develop practical operation and management strategies for peri-urban areas
- Demonstrating safe resource reuse by sanitising food waste mixed with source-separated faeces using different composting techniques.

Fig. 3: Setting up of a compost windrow (photo by Samuel Olweny, 2009).

3 Location and conditions

Kitgum Town is the administrative centre of Kitgum District which is located in Northern Uganda, approximately 450 km north of Kampala, the capital of Uganda. Kitgum Town covers an approximate area of 30 square km and is situated at an altitude of 937 meters above sea level at the bank of River Pager.

The climate is hot throughout the year, with two marked rainy seasons from March to June and August to November, whereas the rest of the months are dry and windy. The mean annual maximum temperature is 31.8 ˚C and the mean annual minimum temperature is 17.3 ˚C, giving an overall mean annual temperature of 24.6 ˚C. The average annual rainfall adds up to 1130 mm.

The current population of Kitgum Town is approximately 62,000 inhabitants living in 8,500 households spread in 11 parishes and 32 villages.

Prior to 2006, the situation in Kitgum Town was characterised by three major factors:

a) exponential growth of the population, worsened by an influx of people – both semi-permanent residents and night commuters – fleeing from insecurity in the villages due to a precarious security situation (rebellion)

b) extremely low per capita income and inadequate access to external funding (donor funding)

c) lack of human resources as a result of the insecurity

Starting from a sanitary situation mainly based on the use of pit latrines, altogether these framework conditions led to the present situation where only a minority of people have access to sanitation facilities.

Kitgum Town Council (KTC) ranks solid waste management top on their list of sanitation problems followed by uncontrolled wastewater discharge in the central areas of town. However, the lack of adequate sanitation facilities, like toilets for excreta disposal in the peri-urban areas of the town, seems to be equally or even more important, particularly when considering the number of people concerned.

The rebellion ended in 2007, since then Kitgum Town is growing and numerous constructions are taking place in the area. Currently, there are efforts of people investing in sanitation systems and especially in ecological sanitation systems (such as urine diversion dry toilets (UDDTs), greywater tower gardens and composting).

Agriculture is the major source of income in Kitgum district with more than 85% of the population relying on sales of agricultural products. Not only in Kitgum, but also in a nationwide context is agriculture contributing largely to the economy despite mostly being carried out at subsistence level and a low degree of industrialisation.

Both cash and food crops are grown in Kitgum Town and surrounding areas. Food crops comprise beans, maize, peanuts, sweet potatoes, cassava, bananas, soya beans, sorghum, millet, cabbages, sesame seed and rice. Cash crops include: maize and sun-flower. Also grown on small scales are fruits like papaya, mangoes and oranges. Animals kept include cows, goats, sheep, pigs and poultry. People in the central part of the city, are engaged in commercial activities such as wholesale and retail business, vending in markets, and petty businesses including brick making.

In Uganda, the under-five child mortality rate[1] is currently 130 children per 1000, which is very high but at least there is currently a clear downward trend towards fewer child deaths.

4 Project history

The ROSA project started in October 2006. The first activity of the project was to conduct a baseline study, which was concluded by March 2007 in order to get basic information about the sanitation situation and the status of reusing nutrients from excreta, wastewater and greywater (ROSA, 2007).

The baseline study was carried out using local community maps, questionnaires and checklists. Focus group discussions, key informant interviews and interviews with the local community were held. The data was analysed using SPSS and EPI Info software packages. Local/international laws/regulations relevant to ROSA were reviewed; town wide data was collected, key features geo-referenced and plotted on the town map.

The baseline study findings were disseminated in a workshop for local/opinion leaders, technical and NGO staff working in KTC. In order to select system types for piloting, to carry out research and later implementation, local leaders, being the decision makers on behalf of the communities, were trained on a Multi-Criteria Decision Support System (MCDSS). This is a decision making tool that takes into account different criteria, such as various components and characteristics of a sanitation system enabling the user to make informed choices on sanitation options suitable for individual areas as well as treatment systems for faeces and food wastes to produce hygienic compost manure.

Local leaders provided input for the development of a Strategic Sanitation and Waste Plan (SSWP) and decided that pilot urine diversion dehydration toilets (UDDTs) with resource utilisation were constructed as learning objects.

Additionally, a demonstration of composting at household and community level for sanitising faeces and food wastes and converting them into soil conditioner completed the efforts. Considering the fact that the municipal solid waste collection rate was very low compared to the generation, coupled with frequent vehicle breakdowns and the cost of fuel, the Town Council and local leaders considered on-site organic waste processing via composting to be an important way to sustainably manage domestic wastes.

Nine households were identified and trained by ROSA, the Ecosan Club Austria (ESCA), and Kitgum staff (people working at the Kitgum Town Council) in February 2009 to carry out composting of solid waste and faeces. By July 2009 all targeted households had adapted the composting technique and were practicing it with minimum supervision from the ROSA staff.

The quick adaptation can be explained by the efforts put into sensitisation and training of the community. At the moment, all organic waste from the sample households is composted and applied to the gardens. Since it takes about a year for a

[1] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before reaching the age of five if subject to current age-specific mortality rates (http://www.childinfo.org/mortality.html and http://www.childmortality.org/).

chamber to get full, the people who use UDDTs also compost the organic waste with dried faeces[2].

5 Technologies applied

Compost can be prepared in different forms or methods. The methods of aerobic composting most commonly applied are: Passive Pile Method (PPM), Aerated Static Pile Method (ASP) and Windrow Method (Haug, 1993). After a short overview about different methods is given in Section 5, a detailed description of the methods applied in the project[3] is given in section 6.

Passive pile method: In this method organic materials are placed in a pile and left for decomposition over an extended period of time. The pile is not aerated and its temperature, which is critical to proper composting, is not monitored. Passive compost piles often turn anaerobic. In this case, organisms that do not require oxygen, take control of the decomposition process, thus creating offending odours.

Aerated static pile: In this method the compost is not turned either. Instead of that, air is supplied for microbial activity through perforated pipes that are placed along the bottom of the windrow or pile. Composting is faster with the aerated static pile method.

Windrow method: In the windrow method, a mixture of feed stock materials is placed in a long, narrow pile. The pile is turned or mixed on a regular basis to provide oxygen throughout the pile. How often the windrow pile needs to be turned is determined by a variety of factors including the temperature, moisture level and porosity of the pile. The advantages of the windrow composting process include thorough mixing of materials.

6 Design information

Passive pile

Set up: As a first step, organic matter such as food residues (except meat and grease), leafs, weeds and faeces (from UDDTs) are piled up in an appropriate place. The pile it then left for decomposition. During this process the pile will reduce its volume and might release some offending odours.

To finally form compost, it takes between six months and two years from the time the material was accumulated, depending on the size of the pile, the material used and the climatic situation. The status of the pile can be checked by opening a part of it. When the colour of the material has turned blackish, the compost is finished.

Windrow

Set up: A windrow was constructed in a trapezoid shape with 2.5 m width and 1.3 m height (cross-sectional area approx. 1.6 m^2). The length of each windrow was chosen according to the size of the land available and the amount of materials to be piled at once (Fig. 4).

Fig. 4: Windrow covered with grass and mango leaves in Mrs. Aleng Christian’s Home (photo by Samuel Olweny, 2009).

Generally shorter windrows were considered to be better to manage and to facilitate the mixing process, especially as the mixing of the material was done manually. A path or space of about 2.5 m was created between the windrows and they were constructed with a 5% slope towards a collection pond for the generated leachate.

Finally, the composting site should provide enough space for the collection of bulk materials and organic waste, an area for active decomposition (windrow), space for the curing stage, tools and storage of the end product (Fig. 3).

Piling and composting: Feed stocks (a mixture of food waste and faeces) and bulking materials (straw or sawdust) are mixed together according to their density and moisture level and spread into rows or piles. A commonly applied mixture ratio is 1:1. The whole length of a windrow should be made at once and piling starts with feedstock followed by bulking materials. The amount of water to be added depends on the moisture level of the feedstock and bulking materials.

After piling, micro-organisms in the mixed materials begin to feed on the nutrients in the raw material. This phase is an active decomposition phase where the windrow temperature will increase considerably.

Turning windrows: During this stage, frequent turning of the pile is important to mix the compost well, thus increasing aeration and lowering high pile temperatures. As a side effect the odour production will be minimised. The physical structure of the windrow affects the overall porosity and determines how well or how poorly a compost mix is aerated during the process.

Poorly aerated compost requires the most management in order to prevent potential build-up and release of offensive odours and a decrease in compost quality. Well aerated compost will reduce the amount of turning and improve compost quality, but can also lead to rapid drying of the compost before it has fully decomposed.

If the mix has a good structure in terms of porosity, then the windrow will only need to be turned 2-3 times during the entire process. The main reason to turn is to incorporate the material that is located on the edges and the outside of the pile or windrow into the inner regions where composting happens at a much more accelerated rate. Generally, while

[2] Answer from the main author regarding the number of operational UDDTs in Kitgum now: “It has been long since I last went to Kitgum so am not sure of how many people have UDDTs, and the person I could ask now left Kitgum”.
[3] The windrow and the passive pile method were applied at the households due to small investment costs and a low complexity. Nine households have been identified in February 2009 for initial implementation.

decomposing, the mix tends to settle within 2-3 days of turning, attaining a higher level of density, which in turn requires more frequent turning.

The way of turning and its frequency can be approached differently. As stated earlier, temperature is the main way to monitor the progress of a compost mix. A compost mixture that exceeds 70 °C should be turned to release heat (but simple home composting, such as the method described here, would never reach temperatures this high (see also Berger (2010)). At such temperatures the beneficial microbes needed for decomposition begin to die off. For compost mixtures that have a moisture level of around 75%, turning can help release water vapour.

However, turning the compost too often can result in too much moisture being released. If both air and water are present and the pile has been mixed, either composting is finished or more nitrogen or carbon needs to be added for example by the addition of ash.

Monitoring the process: The temperature can easily be monitored by placing a hand into the pile. If the hand is not pulled back after some minutes, the temperature is below 50 °C. When the hand is pulled back after a few seconds, the temperature is above the 50 °C. If the hand is pulled back immediately, the temperature is above 70 °C which is not desired since certain beneficial bacteria will be lost (as mentioned above simple home composting, such as the method described here, would never reach temperatures this high).

Temperatures within the pile or windrow will gradually drop as active composting slows down and they will level out to ambient air temperature. Temperature could also be measured using a lance thermometer if available.

The moisture level of compost during active composting is recommended to range between 50 to 75%. This can be tested by trying to squeeze out water of a handful of compost. If some drops become visible, the moisture level is correct (Fig. 5).

Curing: When the active decomposition phase is completed after 3-4 weeks time, the compost can be moved to a separate pile where it is left to cure for another 3 months before application to the gardens.

Fig. 5: Estimation of initial moisture level of a mixture of compost and soil by the "squeezing" method (photo by Richard Komakech, 2009).

7 Type and level of reuse

The high generation of organic waste in the town council of Kitgum that remains uncollected und untreated has forced the local people to look for low cost solid waste management options. Composting is one of the options and has been welcomed by the community. Waste that is being generated by households has been turned into compost which is later applied to their gardens as a soil conditioner and hence has increased the yields of the crops grown especially the vegetables (reports, research results and photos currently not available).

8 Further project components

A lot of sensitisation and awareness creation has been put in place concerning composting. Overall, more than 50 households were trained in hands on courses on how to make compost for their gardens. By January 2010, the total number of households performing on-site composting had grown to 100. All households who were trained on composting are doing it at their homes, producing compost for their gardens.

9 Costs and economics

Composting at household level according to the described methods involves zero to minimal costs. The inputs are usually for free and no extra investments have to be made. Some users prefer composting in a pit rather than on the ground to prevent the pile from being disturbed by the wind or roaming animals (goats, pigs and cows) (Fig. 6). The costs of digging such a pit can add up to EUR 25.

Fig. 6: Preparation of a composting pit (photo by Samuel Olweny, 2009).

10 Operation and maintenance

Operation and maintenance involves collection of household domestic wastes that are placed in piles or windrows and left for decomposition. Cow dung is sometimes being added as supplement to the nutrient level of the other wastes. Households that have UDDTs apply source-separated faeces to the compost pit whenever dried faeces are available.

O&M is mainly done by the women with the assistance of their children. Some people prefer the use of windrows while others prefer the use of pits, especially where the spatial extent has to be minimised. Thus, the costs of O&M may be kept minimal or reduced to zero when done by the household members. Otherwise, it is estimated to cost less than EUR 10 per composting period. The costs include the turning of the compost, as well as spreading the compost on the garden.

11 Practical experience and lessons learnt

People's acceptability

- Many homes, whose members have been trained, started composting their organic waste. Most of them have prepared small gardens within their compounds where they are now applying manure and growing their crops.
- By involving people from various villages in the sensitisation workshops, the knowledge about composting could be disseminated extensively.

Lessons learnt

- Only few members of the community were willing and/or had the capacity to pay for their solid waste collection by private operators (the collection cost varies according to the particular operator and the weight of the waste). The majority of the households opted for composting to manage their organic wastes and apply the compost in their urban farmland while the few non-biodegradable wastes were taken to collection points where a Town Council truck collects them.
- The quantity of wastes generated at household level in the peri-urban areas of the Town Council is small compared to those produced by households in urban areas.
- Many private operators are sceptical about people's willingness to buy the final compost, considering the product as too expensive (1 kg of compost costs up to EUR 0.17). There are not many private operators in Kitgum involved in the solid waste collection. Usually, bids are made to the Town Council and the one offering the best bid takes up the job.

Challenges faced

- Many households in peri-urban areas only produce small amounts of organic waste. This makes the quantity of compost produced very small.
- Composting requires a certain amount of area for the process itself, the storage of raw materials and the storage of finished compost. Since land area is limited in Kitgum Town, this might pose constraints.
- The odour produced during the process of decomposition can be offensive and may generate complaints from nearby residents and by-passers.

After the end of the ROSA project, information dissemination of composting methods with other projects has been continued by the Kitgum Town Council.

12 Sustainability assessment and long-term impacts

A basic assessment (Table 1) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects represent weaknesses.

Table 1: Qualitative indication of the system sustainability. A cross in the respective column shows the assessment of the relative sustainability of the project (+ means: strong point of project; o means: average strength for this aspect and – means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse		
Sustainability criteria	+	o	-	+	o	-	+	o	-
• health and hygiene		X		X			X		
• environmental and natural resources	X			X			X		
• technology and operation	X			X			X		
• finance and economics	X			X			X		
• socio-cultural and institutional		X			X		X		

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

With regards to long-term impacts of the project, the main expected impact of the project is improved cleanliness of the area as well as increased productivity through the use of compost. This was assessed at the end of the project in March 2010 and is documented in the Town Council reports.

13 Available documents and references

More photos are available from main author.

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Training events, raising awareness

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