Waste reuse article

Frederick Kakembo

Developing Incentives and Capacity for Sustainable Waste Reuse in Uganda

Frederick Kakembo

Ndejje University

P.O. Box 7088 Kampala, Uganda.

fredkakembo@gmail.com

Nassanga Nakate Rhodah

Uganda Christian University

P.O. 4 Mukono

cathyrhodah@gmail.com

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Abstract

This paper explores prospects for developing incentives and capacity for sustainable waste reuse in Uganda. Whereas urban authorities focus on waste collection and disposal as a sole approach to waste management, there is lack of sufficient resources to accomplish the task. It was premised that a combination of economic incentives, capacity building and policy reforms could be more effective approach to waste management. The study transcended the traditional approach that seems to conceive solid waste management and wastewater management as separate entities. Data was collected through qualitative and quantitative methods involving: personal interviews, documents analysis, literature reviews, baseline surveys and feasibility studies. Findings suggest that opportunities and prospects for waste reuse include; high organic components in the wastes, rising costs of firewood and charcoal, existence of private waste collectors, existence of umbrella organizations (such as UWASNET) and availability of preliminary IEC materials. The barriers facing the reuse of waste materials include: low technical skills, high start-up/capital investments, socio-cultural sensitivities, non-conducive policy environment and lack of a supportive institutional framework. It is suggested that barriers could partly be reduced through capacity building initiatives, sensitization programmes, user-friendly financing models and development of an institutional framework to bring together key stakeholders.

Introduction

Waste management involves the collection, storage, transportation, treatment, disposal and/or reuse of wastes. Over the years (1950s, 1960s, 1970s and 1980s) waste management in Uganda has evolved from the highly centralized/controlled systems to a mixture of centralized and decentralized systems; public and private systems [1]. In the process, both municipal solid waste management (MSWM) and wastewater management have become problematic particularly in the urban centers. On the side of MSWM, urban authorities are overwhelmed by the big volume of garbage generated[1]. The amount of solid wastes generated in the capital city outstretches the capacity of Kampala City Council Authority (KCCA). This is because of the enormous costs involved [2]. The rates of solid waste generation in Kampala city (with a population of 2.0 million people) is 0.5-1.2 kg/capital/day. The inefficiency in service deliveries could be attributed to rapid urbanization in Uganda (at the rate of 5.1%) and increasing population (at the rate of 3.3% per annum). The consequent overcrowding and informal settlements lead to poor waste management. The problem is compounded by inadequate resources on part of urban authorities [3]. Collection of solid wastes is relatively more regular in city centers and high income neighborhoods. The urban poor receive very low waste collection services. This could be due to inaccessible roads, unplanned facilities and neglect by urban authorities. A bigger percentage of wastes do not reach the designated dumping sites which makes open dumping a common practice in urban centers [4]. On the side of wastewater management, over 90% of households in Kampala are not connected to a sewage network, meaning that wastewater is discharged without treatment into the environment [5]. Urban authorities in Uganda lack enough resources to treat water effectively without external assistance [6, 7]. The government owned National Water and Sewerage Corporation (NWSC); a body mandated to handle all domestic and industrial wastewater [8] is strained to fulfill its functions. The sewage Treatment Plant at Bugolobi that belongs to NWSC discharges 15,000 m3/day of inadequately treated sewage into Murchison Bay [5]. This means that NWSC could be the single largest polluter of Lake Victoria. The consequent pollution of natural water sources is one of the key sources of oral disease transmission which impact 96% of Ugandans, particularly infants and young children [9]. Health hazards that arise out of this situation cost the country approximately $177m annually [10]. Approximately 23,000 Ugandans, including 19700 children under 5 die each year from diarrhea; attributed to poor water, sanitation and hygiene. The cost of poor waste disposal is also felt in the fisheries sector. The indiscriminate discharge of wastewater into was one of the factors that induced the European Union to ban all fresh fish imports from Uganda, Kenya, and Tanzania between 1997 and 2000. This was done on grounds poor sanitation facilities and inadequate health and environmental conditions [11]. The ban affected not only the economies of the 3 countries, but also the individual households that depended on fishing for survival.

[1] Based on a report by UN-Habitat basic Urban services Initiative; Solid Waste Management strategy; Guiding principles and strategy options. International Water and Sanitation Centre IRC (2005)

From the foregoing discussion, two facts are evident; the first is that the management of wastes by local authorities in cities and municipalities in Uganda is below satisfaction. The second is that the sub-optimal performance has health and environmental costs. While there are several segments of wastewater management, urban authorities seem to focus on the model of collection, treatment and disposal which itself is not efficient and effective [3]. The approach does not seem to be providing efficient and effective services to address waste management issues and challenges. This paper is based on the assumption that socio-economic incentives, technical capacity-building and policy reforms could be the way forward to sustainable waste management in Uganda. While cities and municipalities may not have sufficient human and financial resources to address waste management sustainably, the private sector could be engaged to bridge the demand-supply gaps under the principle of Public Private Partnership (**PPP**)[2]

Conceptually, the private sector will invest resources in waste management only when economic viability is demonstrated. Bio-fuel and soil nutrients recovery potentially has direct financial [12]. A bigger component of solid wastes generated in Ugandan cities and municipalities is decomposable organic materials [13, 14]. Bio-fuel and soil nutrients could be recovered and sold on a commercial scale by the private sector agencies. The organic wastes comprise of vegetable matter of crop waste generated in markets by sellers of food related materials [15, 16]. Other components of wastes that are made up of paper, plastic, glass and metal [12, 13] could also be recycled in different ways. Wastewater also is a raw material for bio-energy. The need for biogas as a renewable energy in Uganda cannot be overemphasized. The cost of lighting energy on average is 20% of household budget and the average monthly cooking energy is $ 26, constituting 40% of the household budget [17]. Over 90% of household rely on wood and charcoal as a source of energy, resulting in respiratory health issues[3]. Cooking accounts for about 90% of all household energy consumption. More than 60% of the total wood used in Uganda is used as wood-fuel. More than 90% of Ugandans depend on wood-fuels for cooking and only 5% have access to electricity. Every 20 years, households consume 6 hectares of forests which are not replaced [18]. The use of biogas for lighting/cooking saves lives and the environment. A house with an open fire can have up to 75 times the maximum advised level of air pollution [5]. Over 75% of Ugandans suffer from respiratory health (ibid). The presence of nutrients such as nitrogen, phosphorous, potassium and zinc in wastewater bio-slurry is useful for agriculture as it enhances soil productivity [19].

[2] PPP is defined as "The combination of a public need with private capability and resources to create a market opportunity through which the public need is met and a profit made." Heilman, J. and Johnston, 19992; the politics of economics of privatization, university of Albama Press P 197

[3] National Biomass study project, Technical report September 21 2003

Existing studies and practices seem to dichotomize waste management into separate fields of 1) solid waste management and 2) wastewater management. This is understandable given that the two spheres appear to be distinct, calling for diverse approaches, diverse professionals and diverse technicians. It is hereby presumed that there are important synergies between the two fields. For instance, there is greater potential for generating high quality bio-energy when solid wastes and wastewater are used as feedstock through co-digestion. Existing technologies within the country allows solid wastes and wastewater to be processed within the same digester to produce bio-energy and bio-slurry. Beside the technical advantages arising out of co-digestion, there are socio-economic and environmental benefits. Among them is the heightened incentives (on part of communities and investors) to collect both solid wastes and wastewater as raw materials for their enterprises.

The central purpose of this study was to investigate possible incentives and capacity-building needs for sustainable waste management in Uganda. The specific objectives of the study included; 1) to investigate likely facilitators for the sustainable reuse of solid wastes and wastewater in Uganda; 2) Establish chief barriers hindering sustainable reuse of solids and wastewater in Uganda; 3) Determine approaches and procedures for optimizing facilitators and for addressing barriers for sustainable waste management in Uganda.

Materials and methods

The section below presents the approaches and methods used to collect data related to facilitators, barriers and potentials for developing incentives and capacity for sustainable waste management in Uganda.

Reviews of related literature: Ideas and facts related to the past, present and prospective reuse of solid waste and wastewater was obtained through reviews of related publications within Uganda, East Africa, Africa and other parts of the world. The information relates to prospects, opportunities, barriers and other aspects of waste reuse.

Documents analysis: Data was generated through analysis of documents from government ministries, departments and agencies. These included among others, the Ministry of Water and Environment *MoWE;* National Environment Management Authority (*NEMA)*; National Water and Sewerage Corporation (*NWSC*); Kampala City Council Authority *(KCC*A)[4]; and the leading NGOs associated with waste reuse (mainly those under the umbrella of Uganda Water and Sanitation Network (*UWASNET*). Additional information was obtained from proceedings of Kampala-based workshops conducted by United Nations University Institute of water,

[4] Among other documents, policy beliefs were consulted.

Environment and Health (*UNU-INWEH)* Canada[5]. Other documents reviewed included Information; Education and Communication (IEC) materials so far developed on waste reuse.

Interviews: Information was obtained from interactions with; key waste-reuse practitioners, selected representatives of the private sector organizations, existing investors and other key stakeholders in; relevant governmental Ministries, agencies and departments (*MoWE*; *NEMA*, *NWSC*), City councils, Municipalities and Town Councils; and leading NGOs associated with waste reuse (mainly those under the umbrella of UWASNET) and academia (researchers in related departments in Universities[6]). Users and other beneficiaries of bio-energy systems were also interviewed. Details provided during the interviews included views generated on the initiatives and level of success of waste reuse in Uganda.

Field observations: Field visits were carried out on successful waste reuse project sites many parts of Uganda. Other sites that were visited include thee informal settlement (slums of Namuwongo) in Kampala district and the highly populated landing site in Kiyindi, along Lake Victoria shores. Observations were carried out to verify the information that was generated during interviews and documents analysis.

Feasibility assessment studies[7]: Feasibility assessment of biogas production was made and this included an analysis of nutrient recovery amounts in wastewater. In collaboration with the Ugandan Ministry of water and Environment, the project team conducted Biomethane Potential tests of different biomass types (municipal wastewater, municipal sludge, water-hyacinth and fish guts). The findings enabled the team to develop four case scenarios for Anaerobic Digestion (AD) which were; 1) urban scenarios, 2) informal settlements; 3) rural areas; 4) institutional scenarios. For each of the scenarios, a playback analysis was used whereby capital costs needed for the initial set-up of the installations was determined and compared to the potential net annual revenue that could be generated from each scenario respectively. The net annual revenue considered gross revenues, less annual operating costs. In all these cases, payback was considered directly based on actual estimates and did not include cost variations, or debt costs associated with any initial capital investments. Common values for evaluation parameters were used for all scenarios. These included biogas revenue per-tone, bio-slurry drying and briquetting costs, electricity costs and operational labor costs. Different rates for waste/wastewater transfer were utilized.

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[5] The project through which the data was generated is entitled; ***From Waste to Wealth; Sustainable Wastewater Management in Uganda***. This was a one-year proof of concept project. The data generated included feasibility assessment studies and baseline studies which were disseminated through two workshop proceedings.

[6] The researchers were mainly from Ndejje University and Makerere University

[7] The feasibility study was conducted through; ***From Waste to Wealth*** project**.**

Findings of the study

In the following section, the findings of the study are presented, describing the current status of waste reuse in Uganda; the facilitators, opportunities and potentials for waste reuse; the barriers and shortfalls hindering waste reuse; and the policy and institutional framework for waste reuse in Uganda.

Existing patterns and trends of waste generation, collection and disposal[8]

Out of the total wastes generated, residential places account for 52-58 % and the markets generate 4-20 % of the wastes. The wastes are mainly organic wastes constituting food-wastes and vegetable wastes (leaves, stalks, spoilt fruits) respectively. The Non-organic components wastes include paper, plastic, textiles, glass, ceramics; ashes, leather and compound wastes and packaging materials. The commercial places generate 3.7-8% much of which are packing materials (sacks, bags, paper and timber). Institutions, government department, private organizations, educational institutions, clubs and sports facilities generate 5% which constitute food wastes, stationary packaging, cardboards, paper and plastics). Manufacturing industries generate 3% of the wastes which mainly comprise of decomposable wastes from food industries; non-degradable wastes such as broken bottles and plastic containers. Health care facilities (hospitals clinics, drug shops) generate domestic types of wastes as well as hazardous wastes (anatomical, contaminated materials, sharp objects). On average, waste generation in the low income zones that are densely populated (including the informal settlements) is lower, estimated between 0.22 and 0.3 kg/cap/day; Higher income households generate more wastes; between 0.66 and 0.9 kg/cap/day. It is believed that the low incomes buy little and are less wasteful in consumption [3, 20]

In regard to waste collection, only 35 (40%) out of the required 85 refuse vehicles in the city were operational by March 2010. Constant vehicle breakdown has led to accumulation of uncollected garbage to undesirable levels and this is evidenced by the presence of refuse which has taken more than day without being collected. Skips and waste bunkers have been terminated in many parts of Kampala since 2002; largely due uncleanness and discontentment on part of residents. This has culminated into open disposal. KCCA spend USD 1.53 million per month to

[8] The data is based on the studies of Liyala (2011); Scheinberg (2011); Oberlin (2011) and Okot-Okumu & Nyenje 2011)

remove only 30 % of the total generated garbage [21]. Out of the 1200-1500 tons of garbage generated daily, only 400-500 tones are collected, constituting a collection efficiency of 36-40 % [16]. The introduction of private operators to work side by side with urban councils has increased the waste collection levels [3]. However, both urban councils and private companies focus on well to do households. NGOs and CBOs who participate in waste collection, recycling and disposal focus on the less privileged urban communities [22]. In so doing, they serve a population bigger than the one served by private companies and urban councils combined. The combined efforts of the private and public sector could enhance waste management [23]. There is growing willingness of urban residents to pay for solid waste collection; between 1000 -3000 in formal settlements and between 200-500 shillings informal settlements [24]

With regards to waste disposal, the common methods used by households include burning, backyard burning and open dumping. Solid wastes are openly dumped in open lots, roadsides and drainage channels which increase the cost of waste management about 2-3 times [25]. Besides, open dumping culminates into flooding particularly when the wastes block the storm-drainage channels. The other common destination for large volumes of solid wastes is the environmentally sensitive wetlands, including those adjacent to water bodies (sources of water for domestic use). Waste dump sites often receive mixed wastes from domestic, industrial, medical and commercial wastes. The disposal poses dangers to people, animals and plants.

Almost 90% of households are not connected to a sewerage network, meaning that wastewater is discharged into natural environment without treatment. As is the case with solid wastes, privatizing wastewater collection is problematic because private collectors are only willing to operate from well to do families that can afford to pay for the services. According to UNICEF, nearly 66% of Ugandans live without basic sanitation and are exposed to sanitation-related diseases such as diarrhea, malaria, measles[i] etc.

Trends in reuse of solid wastes

The existing form of recycling of solid wastes is the assembling and selling of plastic and metallic wastes and selling them to recycling agencies. Some of the separated wastes are sold to artisans and women groups who convert them into items such as hats, bags, necklaces baskets, door rugs, mats and seedling cups and crafts. The business motive is considered central in this practice. Informal waste collectors operating at a fee in urban councils deal directly with households, markets and other establishments. Another common form of waste reuse is the feeding of animals (such as pigs and dogs) with food left-over. While practice is a rational way of making use of food wastes, the feeds could be contaminated. On the other, the fact that the food wastes have an alternative use (as a feed for animals), it becomes a costly feedstock for the biogas project.

Currently, both compositing and anaerobic biogas production are on individual basis and therefore insignificant. The production of bio-energy (bio-energy and briquettes) and compost is

done on a relatively small scale because it is being championed by small scale entrepreneurs. Anaerobic biogas production is being done by high income households in peri-urban areas, majority of whom depend on use of cow dung[9]. Many of these informal set-ups are not easy to assess and monitor. As it the case with biogas production, reuse of waste through compositing is still on a small-scale and is insignificant. Compositing, which is being piloted in 11 urban councils under the *Clean Development Mechanism,* has scored differing levels of success [13, 3]. The main problem associated with compositing is sorting which is done at delivery points instead of being done at source (by people who generate the wastes). Consequently, the task of sorting becomes labor intensive. Besides, the process is risky health-wise because the wastes occasionally have a mixture of various materials.

Facilitators, opportunities and prospects for reuse of waste materials

Involvement of multiple stakeholders is presumed to be central for sustainable reuse of wastes in Uganda. The private sector involvement in particular depends on; 1) capacity building initiatives; 2) economic incentives; and 3) and a supportive policy framework. Already, there are some private operators engaged in waste collection and disposal. One such group is Private Emptiers Association (***PEA***). Their paid-for operations however do not stretch draining of septic tanks in homesteads and institutions to disposal points. It is presumed that through capacity building initiatives, the scope of activities of private operators could be broadened to include treatment and processing of wastes into bio-energy and soil enhancement products. Achievement of this goal requires a steady market and demand for bio-energy and fertilizers. Given the fact that socio-cultural factors could impede the uptake of waste by-products, developing of outreach materials for education and sensitization becomes an additional necessity. In the section below, the opportunities, prospects and facilitators that are likely to enhance sustainable waste reuse in Uganda are discussed. These include;

High organic components in the wastes: The highly decomposable bio-waste and optimal moisture content in the solid wastes (for aerobic decomposition) make it suitable for compositing [13]. The wastes are characterized by the following; PH (5.7-6.9 %); moisture content (50-75%) relative humidity 75-155%) volatile solids (66-79%) decomposable organic carbon DOC 74-86%). Methane emission potential from the wastes vary between .9 and 4.12 Gg/yr.

Business opportunities: findings from a feasibility assessment of biogas production in Uganda revealed attractive returns on investment[10]. The study which was based on 4 scenarios suggests

[9] This is based on the study conducted by Muyiiya and Kasisira entitled; Assessment of the effect of mixing pig and cow dung on biogas yield, agricultural engineering international,. The CIGR E journal. Manuscript. PM 1329, vol xi 2009

[10] The findings are part of the study entitled; From Waste to Wealth; Sustainable Wastewater Management in Uganda. see http://inweh.unu.edu/waste-to-wealth/

that the maximum payback period on the invested capital is 5 years. The various investment scenarios are illustrated thus; **a)** Within formal urban settlements, an investment of $1,800,000 generates annual revenue of $357,742 with a payback period of 5.03 years; **b)** In urban informal settlements; an investment of $3872 generates $3580 annually with a maximum payback period of I.5 year; **c)** In rural-settlement, an investment of $14,304 generates annual revenue of $21,997 with a maximum payback period of one year; **d)** In institutional set-up, an investment of $7732 generates annual income of $1553 with a payback period of 5 years. The smaller scale biogas systems have more promising business potentials and have a payback period of less than a year. Significantly, the systems effectively serve populations with limited access to sanitation facilities. Investments make economic sense even in absence of social benefit accounting. The main bio-energy products include biogas, fuel briquettes and bio-slurry.

Rising costs of alternative energy sources: For a long time firewood and charcoal have been cheaper than briquettes, making it difficult for investors to sink their money into bio-energy production. With the rise in costs of charcoal, investors are likely to realize the business prospects of producing briquettes. As forests deplete, price of firewood and wood-charcoal goes up. As pointed out by a resident in Mukono, family of six people use up to 25kg of charcoal briquettes and spends about 8 USD every week; compared to 20 for the ordinary charcoal. A kilogram of charcoal briquettes which goes for sh800 is enough to cook one day meal for one person. One respondent narrated that about 20 years ago, a factory was set up to make briquettes using coffee husks as the raw material at Namulesa Coffee Factory near Jinja, but it closed because there was still a lot of wood to produce charcoal cheaply. Another respondent commented thus: “There have been many failed attempts to make briquettes overtake charcoal; prospects for briquettes making industry have never been brighter than now”. The cost of electric lighting energy on average is 20% of the household budgets. The average monthly cooking energy is $ 26, constituting 40% of the household budget[11]. On the side of fertilizers, there is an increasing global shortage of phosphorous[12]. One of the persons interviewed described briquettes as burning and lasting longer than charcoal. Another one observed that briquettes have high heat intensity; they do not spark and they produce less smoke compared to charcoal; which makes it safer to be used in areas of low ventilation. Therefore, briquettes have lesser adverse effects on health compared to firewood and wood-charcoal which are associated with coughing, headaches, respiratory diseases and lung cancer. The fact that they are smokeless means that they provide more energy than charcoal. The briquettes are also economical and affordable, eco-friendly and provide employment to some of the most disadvantaged urban residents.

Existence of private sector actors and umbrella organization: for both solid waste and wastewater handling, there are private firms that provide services for a pay. One of the most

[11] Based on the study by Smith *et al* (2012).

[12] See the Final report of NETWAS UGANDA (2011) and a study by Berg et al. (2005)

outstanding one is the Private Cesspool Emptier Association (PEA). There is an umbrella organization Uganda Water and Sanitation Network (UWASNET) that bring together NGOs, CBOs and other operators that deal in water and sanitation. Interventions that promote waste reuse could make use of these opportunities.

Information, education and sensitization: There is documentary evidence pointing to the availability of information, education and communication (IEC) materials on biogas systems. However, the print materials are mostly in English which is not widely understood by grassroots communities. The materials are also too long and too wordy to be read and comprehended. On the other hand, local radio stations such as CARITAS-Lira have attempted to be clearer and have a wider coverage. The fact that radio messages are conveyed in local languages benefits people who cannot read and write. The only gap with radios is the lack a visual component for demonstrations. This shortfall is occasionally addressed by site-visits to biogas plants. The visits made by individuals constitute one of the avenues for education, training and sharing of best practices. The same opportunities could potentially be used to learn about basic management principles such as projects monitoring and evaluations. An informant was quoted saying; "*If it were possible I would request Uganda domestic Biogas Project (UDBP) Organization to teach us more methods of converting waste to wealth*" (female participant commenting on briquettes technology). There is however much to be done in the area of education and sensitization in order to reduce socio-cultural sensitivities that affect scaling-up of biogas projects.

The opportunities, prospects and facilitators discussed above could be great incentives for developing a framework for sustainable reuse of solid waste and wastewater in Uganda. Successful interventions however depend a lot on identification and minimization of potential barriers and shortfalls. The identified barriers and shortfalls could then be minimized through capacity building initiatives.

Barriers and short falls facing waste reuse

Technical issues in biogas production: One of the barriers in the smooth running of waste reuse is the lack of adequate skills to set up, operate and maintain the bio-energy systems. There are occasional leakages of the biogas line from the dome to the cooking stoves. Once the system is not fed continuously and appropriately, it will not be possible to achieve constant production of biogas. On many occasions, technicians are not available to fix problems of the biogas leakages. Besides the inefficient skills for installing and maintaining the systems, producers of biogas cannot pack it for sale beyond immediate neighborhood. Availability of accessories is yet another limiting factor. Mantles for biogas plants and other appliances used for lighting cannot easily be accessed at the local markets after the initial installation by the implementing organizations. In cases of damage of an appliance, replacement is not easy because there are no nearby suppliers.

A related limitation in biogas production is the rudimentary practices. Biogas plants require intensive labor to stir up the feedstock before putting it into the plant. Many potential and existing operators of biogas installations dislike the procedure of using bear hands to mix the feedstock even when cow dung is the only feedstock used. Another disliked procedure is the manual removal and disposal of the slurry from the biogas plants. The operations would probably improve with developed techniques of handling the feedstock and the bio-slurry.

Slow lighting capacities of briquettes: Some of the interviewed respondents indicated that compared to wood-charcoal, briquettes are hard to light and they produce a lot of ash. It is hard to keep the fire going if more briquettes are added during cooking time. It was suggested that usage of briquettes requires time and that they are not suitable for quick cooking tasks. Besides, distribution centers for briquettes are not as common as those for charcoal. Nonetheless, many respondents felt that the positive aspects of the fuel outweighed the negative.

Socio-cultural sensitivities: Analysis of the interviews with biogas operators and users suggest that socio-cultural sensitivities affect the scale of waste-reuse. During the survey, there was no functioning biogas system that was found utilizing human excreta alone. Out of the thirteen biogas operators interviewed, 38% used cow dung only for the biogas production; 23% used a mixture of cow dung and pig manure for biogas production while 15% used a mixture of cow dung and human excreta. Acceptance of biogas is always very low when potential users confirm that human excreta are added to the digester. The majority of potential users suspect that systems fed with human excreta could be unhygienic and may produce bad odors. An additional socio-cultural factor influencing the uptake of bio-fuels is the belief by many people that the use of firewood and wood-charcoal in cooking improves the flavor of food.

High start-up/capital investments: Scaling up of bio-energy production is constrained by high start-up costs for biogas digesters. The smallest biogas plant of volume $4m^3$ costs not less than US$ 630. The cost is considered prohibitive for an average Ugandan. A related limitation is the lack of availability of land for effective operation of biogas systems. Land is particularly scarce in urban areas where waste generation is more intense. Space for storage of huge volumes of the garbage (largely organic) is a big problem. Within the urban centers, there are multiple land tenure systems; characterized by land fragmentation. Storage of wastes, setting up of biogas plants, disposal of bio-slurry and other processes require big plots of land. Tenants who do not own land may not think of starting the projects even when they have the skills and capital. Landlords in most informal settlements do not provide space for solid management. Addressing the above barriers and constraints calls for capacity building programmes and educational/sensitization initiatives. On the other hand, one of the big incentives that could enhance private investment in waste reuse is the supportive institutional framework and policy environment.

Institutional framework and the policy environment: Policy making related to environmental issues is a function of the central government but implementation of policies and legislation is devolved to the local governments [1, 3, 22, 23]. The responsibility for solid waste management lies with local governments as specified in the Public health Act of 1964 and local government act of 1997. An attempt has been made to spell out duties and responsibilities related aspects of public health, environmental management, urban planning and local governance [1, 23, 3]. The statuary instruments includes, among others, the National Environmental Health Policy (2005); the National Environments Standards for Discharge of effluent into water or on Land, the national environment (waste management) regulation 1999. Many of the existing statuary instruments on waste management are focused on waste disposal instead of promoting alternative management options[13]. Central government and urban authorities are yet to establish a proper mechanism for regulating the operations of private collectors. The informal sector and business communities operate with unclear regulation. Some of the private companies that are allowed to operate have no capacity to collect and transport refuse to the landfill. Occasionally, private operators work is challenged by failure by government agencies to reconcile their responsibilities with private operators. For instance, private cesspool operators face undue competition from their counterparts in government institutions such as police, the army, educational institutions and hospitals. These institutions occasionally operate using public funds and they are exempted from taxes. The private operators find it hard to compete on unlevel grounds. Many of the existing policies are not being implemented effectively [22] due to inadequate resources on part of urban authorities. By law, local governments are empowered to charge fees for waste services [1]. Given that waste collection is not prioritized in urban councils, waste management is poorly financed. Over 50% of the funding comes from external sources such as donors [1]. Some of the policies that are likely to boost private investment in waste reuse include introduction high tariffs on wood fuels. This would make the production of bio-energy a competitive alternative.

Discussions

In the sections above, the opportunities, prospects and facilitators for sustainable reuse of wastes are presented as incentives for private sector involvement in waste management. Barriers and shortfalls are also presented as areas of focus for capacity building. Waste management ought to be focused on improving health, protecting the environment or/and upholding aesthetics values. The central questions for prospective interventions include the following; how could waste reuse initiatives be popularized to the wider community and particularly the low income groups? Can the low income groups afford the initial costs of investment and maintenance? Do the low income groups have access to finance and credit? Can there be commitment from local and central government to build technical and financial capacity for waste reuse initiatives? Could

[13] See Kakembo, F (2011) Innovative Water Management for Lakeside communities in Uganda: The Eco-Hydro-Social Health Approach. Journal of Hydrologic Environment; UNESCO IHP special Edition Volume 7 number 11

waste reuse programmes initiated by NGOs/CBOs be sustainable after they (funders) depart? What potential is there for enhancing cost-effectiveness of the waste reuse initiatives?

Waste reuse as an approach to waste management: Findings from the study suggest that urban authorities in Uganda focus on one segment of waste management; collection and disposal which itself is problematic. The approach could only be effective after significant adjustments in life-style among communities [26]. It also applies when there is active participation of the communities. In the context of inadequate resources and in absence of adjustment in life-styles, use of economic incentives could be the most practical approach to waste management. Business interests are likely to attract investors and communities to actively engage in waste management. The option of land-filling (which is low-cost) has limitations. During land filling, wastes undergo aerobic decomposition which brings about an unpleasant odor, pollution, vermin and pastes. A case in point is Kitezi landfill located within a human settlement. It causes social discomfort and pollution for the communities around it. Despite the establishment of a leachate treatment plant (using World Bank funding), it is polluting the surrounding environment with heavy metals [27]. Besides, the efficiency of waste collection can be perceived from social dimensions. Clearance of garbage does not depend only on the amounts collected/generated daily, but on the socioeconomic status of the area in question. While generation of wastes is higher in high income households, accumulation of wastes is more pronounced in low income zones/households. This could be attributed to unavailability of collection services [24]. In light of the various challenges associated with the collection and disposal approach, the use of incentives to promote waste reuse becomes rational.

Production of bio-energy and soil implements is a feasible waste management option that has social, economic and environmental benefits. A market study in Uganda indicated that a complete sanitation system for 400,000 urban slums in Kampala can be run without subsidies; by selling fertilizer and soil improvement products[14]. This is significant in the context of the global shortage of phosphorous[15]. In a country where $ 899 million is lost annually due to effects of malnutrition, enhancing agricultural productivity is vital. Bio-slurry could boost soil fertility in rural areas whose productivity is occasionally below 50% [20]. However, waste reuse has cost implications. Socioeconomic factors significantly influence bio-energy production particularly where scarce economic resources are to be devoted for the installation of digesters [28]. Requirements for initial investments are occasionally prohibitive [29, 30]. Policy measures are needed to encourage adoption; including training and capacity building. In this direction, flexible financing mechanism and dissemination strategies are needed. Municipal integration and

[14] Karsten G. (2011) Sanitation for all -an engine of economic growth for urban Africa Sustainable Sanitation Design (SuSan Design) www.sanitationfinance.org/.../Sanitation%20for%20all%20-%20an%20e

[15] See Berg, U., Donnert, D., Ehbrecht, A., Bumiller, W., Kusche, I., Weidler, P. G. & Nuesch, R. (2005). "Active filtration" for the elimination and recovery of phosphorus from waste water. Colloids and Surfaces a-Physicochemical and Engineering Aspects, 265 (1-3): 141-148.

support is necessary to boast local community capacities and initiatives towards waste reuse. Without such support, technically viable initiatives may not be afforded [4]. Aerobic compositing is environmentally important as it eliminates GHG emission that occurs during waste decomposition at dumpsites or landfills [13]. Besides aerobic compositing, the use of bio-slurry in urban agriculture is promising. There is a growing application of bio-slurry in the operation of tree-nurseries and ornamental agriculture in urban areas in Uganda.

Sustainability and scaling-up of waste reuse: Civil society and the private sector seem to be taking the lead in innovations that promote waste reuse. For instance, the few individuals who make biogas and briquettes are trained and funded by NGOs and CBOs. They make biogas and briquettes in small quantities for their own use and for sell to immediate neighbors. In light of that, they cannot achieve the scale of production needed to make briquettes a serious alternative to firewood and wood-charcoal. Ultimately, factory-scale production of biogas, briquettes and fertilizers is needed. It is imperative that waste reuse operations become economically viable and self-sustaining such that when the initial external funding is done, the operations could be sustainable. Capacity building (by way of training) and development of workable financing mechanisms are crucial in achieving this goal. Government departments are expected to have a bigger stake in the prospects of waste reuse because they stand to gain more from the environmental and health-related benefits. Production of bio-fuels from wastes saves a big volume of trees that would perish through the use of wood-charcoal and firewood. The 2009/2010 household survey conducted by the Uganda Bureau of Statistics revealed that in Kampala alone, 76% of the population use wood-charcoal as their main source of cooking fuel. According to the UN Food and Agriculture Organisation (FAO) report shows that between 1990 and 2005, Uganda lost 26% of its forest cover (78% of this from areas around Kampala). It was predicted in the report of National Environment Management Authority (NEMA) that the rate at which trees are cut may lead to complete depletion of the nation's forests by 2050[16]. On the side of health, the use of biogas for cooking is likely to save people from health issues associated with household air quality. Use of firewood and wood charcoal is linked to pneumonia, lung cancer and chronic disease; leading to 1.6 million pre-mature death annually [31]. Incidentally, poor people are more likely than the rich to use fuels that compromise air quality. Despite the existing informal production levels of bio-energy, market for biogas and briquettes exists. A study by GVEP indicates that while briquettes may not wholly replace wood-charcoal, there is sufficient feedstock material for the briquette industry to be much larger than it is. In this direction, organizations such as GreenBioEnergy are promising to scale up production. Green Bio Energy produces 1.2 tons a day and owns machines which have a capacity of generating two tons of briquettes per day. A 1.2kg bag of briquette sells for US35 cents. That is about 80% of the price of the equivalent weight of charcoal.

[16] "The state of environment Uganda 2008"

Education for awareness and capacity building: Apparently, the technology of converting wastes into valuable end-products exists in the country but has not rolled out to have a significant impact. Educational initiatives are needed to; 1) increase awareness of value of wastes 2) demonstrate economic viability of waste reuse; 3) develop skills and capacity (for setting up and maintaining low-cost/low tech designs of biogas digesters); 4) develop financial management of associated projects and; 5) reduce socio-cultural sensitivities and risk perceptions associated with reuse of human wastes. Health, environmental and socio-economic considerations justify the potential investments in waste reuse. Socially, women/girls save time when they have improved access to nearby safe water and clean cooking fuel. There is likely to be high productivity of labor and reduced health spending following reduced health risks [32]. Capacity building initiatives could be central for empowering the private sector (such as Private Cesspool Emptiers Association) to; produce and market biogas/soil implements on a business scale; handle innovative management tools; secure start-up credit facilities, manage business and financial practices efficiently; communicate effectively with clients/collaborators and; develop and manage low-cost designs of biogas digesters. One of the practical approaches in this direction is the setting up demonstration/pilot projects to showcase best practices.

Institutional framework: overcoming waste reuse barriers calls for inter-agency collaboration and partnerships between key stake holders such as government, NGOs, CBOs, development partners, private/business sector and the academia. The framework could spell out roles, duties, responsibilities; and also work out modalities of cost-sharing, harmonization of resources (human and financial), reduction of resource duplication, mutual support and sharing of benefits.

Conclusion

In the context where central governments and urban authorities lack sufficient resources to manage wastes effectively, incentives could be used to involve the business community. Facilitators and opportunities for waste reuse that exist in the country constitute part of the incentives for waste reuse. More incentives could be generated through policy reforms and institutional frameworks. In private-public-partnership, private capability and resources are used to meet a public need without forfeiting profits. Integrating solid wastes and wastewater reuse simultaneously for biogas production has multiple benefits; 1) it increases the quality of bio-energy and bio-slurry produced; 2) it motivates communities to clear multiple wastes; 3) it enables communities to earn a living; 4) bio-slurry from biogas plants boosts agricultural productivity. Economic and social benefits of anaerobic digestion provide the financial incentive for private entrepreneurs to collect, treat and reuse wastes. To have optimal utility out of recycling, both solid wastes and wastewater could be used as feedstock simultaneously through co-digestion[17].

[17] Feeding of bio-digesters with diverse feed-stocks such as human excreta; cow/pig dung, organic-garbage and food-wastes (from hotels, fish/meat processing plants)

For capacity building, education and training are vital. Communities need to appreciate the value and application of various wastes (including human excreta). The campaigns should also reduce community sensitivities and imaginary fears. Among other things, this could be achieved through development of user-friendly multi-media materials for Information, Education and Communication (IEC).

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