

Sanitation as Business: Diversifying Income and Livelihoods for Women in Fishing Villages in Uganda

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The paper examines prospects for diversifying income and improving livelihoods for women in fishing villages. It is noted that when social, economic and cultural factors constrain women engagement in the fisheries industry, their livelihood and welfare are affected. Consequently, women are confined to the lower end of supply chains in the fisheries sector. The rapid dwindling of fisheries stocks and the sophisticated export-based fish trade have aggravated the matter. Due to lack of access to economic activities to support them, women resort to selling liquor and commercial sex for survival. In the process, they are exposed to the risk of HIV/AIDS and other sexually transmitted diseases. This study investigates prospects of diversifying their income generating activities; based on the concept of Waste-to-Wealth Enterprises (WWE). Baseline surveys and feasibility studies were conducted to assess the viability and feasibility of WWE. Questionnaires, interviews, documents analysis and focus group discussions were used for data collection. For feasibility studies, laboratory tests on Bio-methane Potential (BMP) for different biomass were conducted in the study area. In addition, proof-of-concept pilot projects were established to verify the viability of various WWE projects. Findings reveal that WWE that are economically feasible include: purifying and distributing water; production of briquettes, production of organic detergents and production of biocides for organic farming. It concludes that diversifying livelihood activities for women is feasible and viable. It however entails re-configuration of gender norms, identifying networks for start-up funding, capacity building and establishment of institutional frameworks.

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INTRODUCTION

Globally, the fisheries sub-sector is exclusively a male domain. Women who constitute the larger proportion of the under-resourced and marginalized groups are excluded in fisheries governance and resource management. While women comprise 46% of the labor force in the fisheries sector, they are engaged in small-scale processing and trading (FAO, World Fish, World Bank 2008). The lack of appropriate equipment for near-shore and off-shore fishing confines them to the lower end of supply chains (Okali and Holvoet, 2007). Existing policies on fisheries focus on regulating catch, gear and access rights and fail to mainstream women's meaningful engagement in post-harvest, processing and marketing. Endless mobility not only limits women's access to education and health facilities; but also tempt them into transactional sex (Bene & Marten 2008), which increases the risk

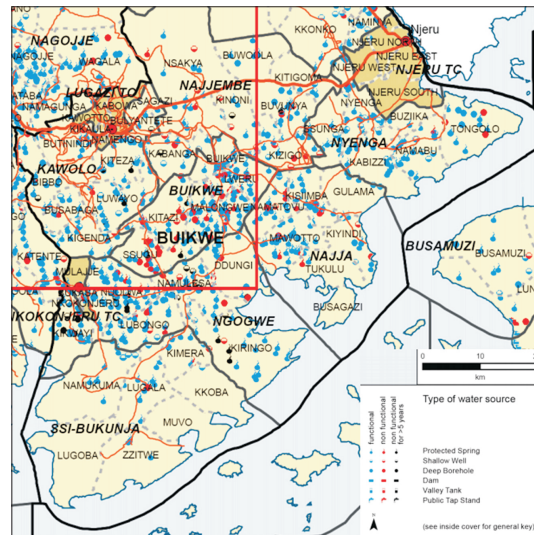


Fig. 1. Map of Buikwe: adopted from a report prepared for ICELDA by Maurice Ssebisubi entitled; The Status Fishing Communities in Buikwe District Uganda; Ref. No.: UGA13050013 (August 2013).

of HIV/AIDS infections. The rapid dwindling of fisheries stocks, the sophisticated export-based fish trade and the industrialized nature of fishing push artisanal women out of business and undermines their livelihoods (Neis et al. 2005). The impact of income, asset and power disparities between men and women are likely to be exacerbated by climate change (Brody et al., 2008). Lakeside communities generally are vulnerable to high risks of disasters related to climate-change. However, the costs to women and children are disproportionate because customary norms and beliefs prevent them from acquiring coping skills such as swimming and accessing information on impending disaster. Women lack ownership of land, capital and other factors of production. Given that fisheries bring relatively lower returns to women compared to men, it is imperative to explore prospects for diversifying their income generating activities. The prospects ought to be within operational areas that support (or are supported by) the fishing industry. This study explores the prospects of Waste-to-Wealth Enterprises (WWE) as alternative livelihood opportunities. The study covers landing sites on the shores of Lake Victoria in Buikwe district in Uganda. This area covers 52 landing sites including Namaziina, Bugungu Ssenyi, Nkombwe, Kikondo Malubya, Muyubwe, Nalumuli, Nansagazi, Buweera, Kizize, Kaazi, Kwasi, Namusenyu and Kiyindi among others. 94% of the landing sites are involved in fishing as a main activity. The premise of investigation advanced here is whether poor sanitation at the landing sites could be turned into an opportunity for income generation for women.

Global and local status of Waste-to-Wealth enterprises (WWE)

Globally, the fecal matter of the 2.4 billion people who practice open defecation is sufficient enough to provide energy to 10 million homes annually, valued at \$200 million (Schuster-Wallace, 2015). The feasibility of dried fecal sludge as a source of biogas and industrial solid fuel was further verified by a study conducted in Dakar, Kampala and Accra (Muspratt et al, 2014). The calorific value found was comparable to other biofuels such as coffee husks, rice husks and sawdust. In another study, the Hofmann kiln in Kampala that uses fecal sludge, produced bricks comparable in quality to those made using other biomass fuels (Gold et al, 2014). Moreover, the use of fecal sludge as fuel generates revenue 2-35 times higher than the sale of fecal sludge as a soil conditioner (Gold et al, 2014). A market study indicates that a complete sanitation system for 400,000 urban slums in Kampala can be run without subsidies by selling fertilizer and soil improvement products (Karsten, 2011). The market potential, however, depends on local factors including existing markets, local industry requirements, legal regulations,

subsidies and locally available materials.

The informal sector dominates recycling in many cities in developing countries. This is due to a lack of clear policy and centrally organized recycling schemes (Ofori-Boateng et al., 2013). Focus is on metallic and plastic materials because the value of organic waste is not known by many (Dangi et al., 2011). The largest fraction of organic waste (over 80%) is dumped in sanitary landfills (Ofori-Boateng et al., 2013). While there are about 500 functioning biogas plants in the country (MEMD, 2006), the contribution of biogas technology to meeting the country's energy needs is negligible. Development of large-scale technology is still at an embryonic stage (Parawira, 2009) due to: a) poor quality plants and material choice due to inexperienced contractors and consultants; b) poorly trained operators/technical knowledge on maintenance and repair and; c) lack of enabling policies to stimulate biogas technology. Thus, there is a lack of efficient technologies and capital for recycling limits of WWE (Ofori-Boateng et al., 2013).

Cultural Factors, Social Norms and Taboos

WWE is greatly influenced by cultural, social and psycho-social factors such as individual, intrinsic motivations, social influences (Ankinée Kirakozian 2015; Kakembo 2012; RRF 2004). Also, religious beliefs, social taboos and myths influence personal and communal attitudes on waste reuse (Furedy & Hanns-André 2009). Despite awareness of the value of human excreta as a fertilizer, it is often conceived as abominable for people to handle human feces alongside food production. A participant exclaimed to other delegates at the Second Dry Toilet Conference in Finland in 2006.

“Food and human feces are not supposed to be even mentioned in the same breath,”

One of the proponents of use of Ecosan toilets in South Africa lamented his experiences;

“In South Africa the perceptions and beliefs of the users represent a major Stumbling block to the use of the products from dry toilets [...] the use of products from dry toilets will not happen automatically in South Africa [...] constant intervention and awareness raising will be needed to address the general norm of not handling feces. A strategy needs to be developed to facilitate attitude change and a mind shift with the users [...] the general norm of not touching human excreta is also strengthened by programs and interventions such as the WASH campaign and other hygiene awareness programs [...] the messages from these campaigns are in direct opposition to the purpose and objective of the closed loop strategy of Ecosan.”

Furedy and Pitot (2012) characterize norms, taboos and norms (cultural and religious) as either faecophobic (excreta seen as extremely defiling) or faecophilic (willing to handle excreta). Each underpins many waste behaviors and reuse practices. The faecophilic aspects do promote “resource recognition” and waste reuse in societies with scarce resources. In such contexts, introducing waste recycling and reuse technologies are likely to be embraced and could impact on the lives of the rural poor. China, Vietnam and India stand out as cultures that have traditionally regarded organic wastes and residues as valuable resources. One of the well-known proverbs in a region in India is “Waste is food”. In many rural farming areas, agro-waste are exploited for fuel, animal fodder and bedding, materials for housing, mulching and soil nutrients. In parts of East and Southeast Asia, sewage water, excreta and solid wastes are fed to fishponds. The faecophobic aspect hinders the adoption of new treatment/reuse techniques. Human excreta evoke the most pronounced reactions especially among many Moslem communities.

In light of the above cultural and social limitations, persuading individuals to participate in waste recycling schemes is complicated. According to the Social Construction of Technology (SCOT) model (discussed in detail in the following section), technology works in a social context (Pinch & Wiebe 1987). The model holds that the reasons for acceptance, modification or rejection of a technology lie in the social set-up of the community. The perspectives of the beneficiaries of the technology are expected to influence the evolution of the technology and therefore, influence the success of the technology. Overcoming perceptions based on cultural and social norms and taboos therefore calls for protracted sensitization; without which innovative recycling schemes may not be

achievable (Robinson & Read, 2005). New norms and behaviors need to be stimulated and maintained among communities (Tucker & Speirs, 2003). As pointed out by Evison & Read (2001), simple, single messages that appeal to the public are paramount for the success of recycling schemes. Because of sensitization efforts, waste recycling and reuse is gradually improving in Kampala city where sludge and urine are used in growing ornamental plants. Small scale farmers prefer to use it instead of manufactured fertilizers due to the low costs involved (GTZ, 2010). Willingness by medium scale farmers to use sludge and urine depends on its distribution networks (NETWAS, 2011). Large scale farmers would be ready to use it if transport costs were low (Schroder 2010).

Within the framework of SCOT, additional barriers for waste recycling include; a) situational factors (Barr et al. 2005); b) contextual and socio-demographic factors (Paraskevopoulos et al., 2003) c) knowledge and awareness factors (including values and attitudes towards the environment); d) environmental factors. The SCOT notion that human action shapes technology implies that efforts must be made to ensure that innovations are situated within the cultural, economic and social fabric of targeted communities.

Conceptual and Theoretical Framework for Sanitation as Business

WWE and the Social Construction of Technology (SCOT) Model

Aspects of waste recycling such as briquettes production are relatively new within communities at the landing sites. Viability of WWE in light of the social, cultural and economic context of the communities can best be conceptualized through the SCOT lens. The model stipulates that technology works in a social context (Pinch & Wiebe 1987). Social structures within the community influence and determine whether a technology will be accepted, modified, adopted or rejected. Members of the community are not passive receivers of innovations, but they influence the evolution and success of the innovations. Communities participate in defining technological innovations and determining the criteria by which success of the innovation are measured. In the context of this paper, technology refers to the innovations for promoting sanitation and environmental sustainability. Thus, the SCOT model implies that innovative approaches to waste management must integrate existing social and economic structures. Particularly, there must be community buy-in to achieve success for waste management initiatives. For a new innovation to succeed, it is imperative to understand the social context in which it operates. The SCOT model contrasts with the Technological Determinism (TD) perspective, which considers technology as the driving force conditioning social change (Klein and Kleinman 2002). TD assumes that technology is an independent factor that impacts on society from the exterior. TD appears to be the model behind conventional developmental initiatives in Uganda, which focus on technology, equipment, physical infrastructure and regulatory instruments. Water management approaches seem to be understood in terms of a hydrologic cycle lens (describing the *physical* laws that govern the movement and distribution of water through its various forms). Despite the existence of physical infrastructure and regulatory instruments, sanitation on land and water bodies continues to deteriorate. Regulatory instruments employed include; National Environment Standards for Discharge of Effluent (into water or on land) 1999; the National Environment Waste Management Regulation 1999 (MWE 2010), the National Environmental Health Policy (2005); the National water and Sewerage Corporation Statute (NWSC) (1995) and many others. Compliance with these instruments is a big challenge because local governments lack sufficient human and financial resources for enforcement (Kyambadde, 2012). Typical waste management approaches are currently based on *collection and disposal* models. They are inefficient given that local government spends 40% of their budget on serving less than 50% of the targeted population¹. It is therefore advanced here that fixing sanitation challenges will need to go beyond technology, equipment and physical infrastructure. The widening demand-supply gap calls for alternative management models that integrate technical, social, economic and governance dimensions.

In line with the SCOT model, sanitation management calls for integration of technological, social, economic

¹Financial sustainability in municipal solid waste management – Costs and revenues in Bahir Dar, Ethiopia, Science Direct, February 2014
<http://www.sciencedirect.com/science/article/pii/S0956053X1300500X>

and environmental dimensions. For instance, in regard to water and sanitation issues, Swyngedouw (2009) proposes management approaches based on a *hydro-social-model*, which conceives nature and society as inseparable. Development cannot be achieved when technological and social dimensions of water and sanitation are approached using traditional fragmented approaches (Heynen et al. 2005). Viable waste management solutions need to be based on modernized mixtures of diverse approaches. For instance, while landfilling keeps waste away from homes they have secondary effects on global warming through methane gas emissions (Scanlan, 2005). A dynamic approach is therefore needed to project future waste flows and to moderate their impacts on the environment (Scheinberg et al., 2011). A multi-criteria decision like the one proposed by Oyoo et al (2013) could help to project waste flows and moderate their impacts on the environment.

From a SCOT perspective, waste management can be analyzed from three dimensions; 1) as a social, ethical and civic duty associated with positive identity (Hetherington 2004, 158); 2) as a product of ‘awareness of consequences’ of failure to take appropriate management measures (Tucker and Speirs 2003, 305); 3) as having concrete social and economic benefits to the individuals in terms of income generation and costs saving. While the focus of this paper is on the third dimension (of Waste to Wealth Enterprise development), the civic duty of managing waste and the fear of adverse consequences (of inaction) will be given deserving attention. Barr (2005) argues that ‘localization’ of environmental action to everyday lives of individuals could have a significant positive impact on recycling schemes and individual participation rates.

Gender, Sanitation and WWE Development

The functions of waste management could be diversified using the principle of public private partnerships (PPP)². This approach looks at Waste management as an enterprise, articulated in terms of business dynamics (Bakker 2003). Increasingly, PPP are emerging as alternative avenues for improving municipal solid waste services³. Conceptually, the entrepreneurial model incentivizes stakeholders to engage meaningfully in waste management. This approach calls for new social norms, new behaviors, beliefs and attitudes. There is a great potential for formation of strong networks (SACCOs) among women to develop WWE. Informal recycling enterprises could create livelihoods for women participants in addition to maintaining a clean and healthy living environment. Presumably, by virtue of women’s subordinate status assigned by social and cultural norms, waste related activities at landing sites could be the only abundant opportunities fully available to them. This potential is further discussed on page 29 (under Women SACCOs in the context of the Social Network Perspective).

Investigating Sanitation as Business

In setting out to investigate prospects for diversifying income and livelihoods for women in the landing sites, the following questions were used as a guide; 1) What are the opportunities and barriers for economic empowerment of women in fishing villages; 2) are WWE feasible for income diversification for women in the landing sites? 3) What are the requirements for capacity building for women in fishing villages to operate WWE? The WWE activities that were identified for this study include; a) recycling bio-waste; b) purifying and selling water; c) making organic biocides (for crops) and organic disinfectants (for pit latrines). To determine the feasibility of income diversification for women in the landing sites and to design business scenarios in the field of sanitation, Kiyindi landing site (KLS) was selected as a case study. The selection was based on a number of considerations. KLS is the biggest and the busiest among all the landing sites on the shores of Lake Victoria in Buikwe district. It has a day population of 42,000 and night population of 32,000 people. Given the size, population and intense business activities, KLS has more informal settlements with poor sanitation (unsafe water, inadequate toilets and general poor health standards). The rocky substrate and sandy shore substrate of KLS makes pit-latrine con-

²‘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, 1992; *The Politics of Economics of Privatization*, University of Alabama Press, p. 197).

³Financial sustainability in municipal solid waste management – Costs and revenues in Bahir Dar, Ethiopia, Science Direct, February 2014 <http://www.sciencedirect.com/science/article/pii/S0956053X1300500X>

struction very costly, endangering the quality of natural spring water.

MATERIALS AND METHODS

Prior studies and document analysis were instrumental in obtaining information on the prospects for diversifying income and livelihoods for women in the landing sites; specifically, information on opportunities and barriers for economic empowerment of women. The same sources of information were instrumental in determining requirements for capacity building for women to operate WWE. Baseline and feasibility studies on the prospects of Waste-to-Wealth Enterprises (WWE) for fishing communities have been conducted since 2013. Part of the study was funded by Grand Challenges Canada and coordinated by the United Nations University (Institute of Water, Environment and health).

The Baseline Study

The baseline study was aimed at determining; 1) existing knowledge, attitudes and practices on sanitation; 2) existing practices on sanitation as business; 3) opportunities and barriers for waste reuse/recycling; 4) possible channels of Information, Education and Communication (IEC); 6) capacity building needs; and 7) start-up and scale-up requirements (financial and technical) for WWE. The baseline studies also endeavored to; a) establish existing costs of energy (firewood, charcoal, electricity); b) determine viability of biogas and fuel briquettes; c) determine potential demand for biogas, briquettes and soil nutrients (in light of potential socio-cultural sensitivities); d) determine marketing processes; distribution; e) determine willingness and capacity of communities to meet costs of water and pay-toilet; f) establish needs for start-up financial facilitation and possible financing options. Qualitative and quantitative data was collected through questionnaires, interviews, documents analysis and focus group discussions. The respondents included fisheries officers, BMU personnel, medical personnel, water vendors, borehole operators, market vendors, the business community; opinion leaders, local government officers (particularly members of the beach management units (BMU) and officers of local civil society organizations (CSO).

The Feasibility Studies

Laboratory tests on Bio-methane Potential (BMP) for different biomass types were conducted to evaluate the amount of methane generated per unit mass of volatile solids (VS). The feedstock tested included solid bio-wastes (fish-guts, food-wastes, water hyacinth) and wastewater from toilets. The studies were also meant to; a) establish existing costs of energy (firewood, charcoal, electricity); b) determine viability of biogas and fuel briquettes; c) determine potential demand for biogas, briquettes and soil nutrients (in light of potential socio-cultural sensitivities); d) determine marketing processes; packaging/distribution; e) determine willingness and capacity of communities to meet costs of water and pay-toilet; f) establish needs for start-up financing options. As already indicated above, the feasibility studies were based at Kiyindi which, by virtue of its informal settlements and population size, could represent the rest of the landing sites.

Proof of Concept Pilot Projects

With regards to briquettes production, a complete chain of briquettes production and consumption has been piloted successfully at St Kizito high school Namugongo; with the following components; i) waste collection bins used to collect and sort waste at source ii) a carbonizer that transforms bio-waste into carbon; iii) a unit that crushes the carbon into biochar; iv) an extruder that moulds briquettes; v) a solar drier that removes moisture from the briquettes; vi) a packaging unit; vii) facilities for storage and transportation of briquettes; viii) a commercial-scale oven that uses briquettes to bake; ix) a kitchen representing use of briquettes for household cooking; x) school kitchen with institutional cook-stoves that use briquettes; xi) smart agricultural units that use biochar (and ash from cook-stoves) as fertilizers and biocides. Students and neighboring communities are practically taken through the various stages. The purpose of the pilot project was to experiment, test and establish

the technical viability of commercial scale production of briquettes for institutional cooking; and the feasibility of briquettes as fuel for institutional cooking. On the side of producing organic soil nutrients, detergents and biocides: small and medium scale units of Lacto Bacili and IMO were produced and pilot-tested for viability and profitability on a wider market. Smart farming units were set-up to test the viability of the items. These products were exhibited in trade fairs, conferences, workshops and other fora; and attracted impressive feedback.

FINDINGS OF BASELINE STUDIES

The section below describes findings of baseline studies; part of which was conducted during a project coordinated by UNU-INWEH 2014⁴.

Safe Water Availability

There were two functional public and two private boreholes. They regularly broke down due to the corrosive pipes, which hiked maintenance costs. There was a spring well (known as Nabirye) which was concrete-enhanced. However, it was distant from the main landing site (about 2 km). Moreover, it is situated on private property which means that it could be closed to the public at any time. Tap water is pumped water from an underground system funded by UNU (INWEH). The pump was designed to use hydro-electric power from the national grid and solar power (donated by UNU Canada). The project could not be sustained due to communal management challenges, particularly the high costs of hydro-electric power and costs of routine maintenance. Solar panels meant to supply cheap energy for the pump were vandalized one week after installation.

Limitations for Bio-waste Recycling

Baseline and feasibility studies on the prospects of Waste-to-Wealth Enterprises (WWE) for fishing communities conducted since 2013 revealed that whereas recycling technology exists in the country, recycling has not rolled out to have a significant impact on sanitation, livelihoods and environment conservation. The constraints identified include; a) low levels of public awareness of value of waste; b) inadequate technical skills; inexperienced contractors and consultants; poorly trained operators and a lack of technical knowledge on maintenance and repair; c) poor quality designs for plants and material choice; d) health-risk perceptions; e) lack of management, and marketing skills; f) inadequate capital for start-up and/or up-scaling; g) non-supportive policy environment and lack of an institutional frameworks. Because of such constraints, bio-energy production (anaerobic biogas/briquettes) and composting are done on a small scale. The few households involved in production of bio-



Fig. 2. Sanitation challenge at Kiyindi landing site. Picture taken at Kiyindi landing site, Buikwe district (Uganda).

⁴From Waste to Wealth; Sustainable Wastewater Management in Uganda. see <http://inweh.unu.edu/waste-to-wealth/>



Fig. 3. Images depicting status of pit latrines and water collection centers at Ssenyi landing site.

Table 1. Heating intensity and burning duration (in minutes) of briquettes made from different bio-waste streams

Composition	boiling time for 10 ltrs of water	Burning duration
Banana peelings	20 minutes	330 minutes
Potato peelings	30	270
Saw dust	35	210
Maize cobs	25	300
Irish peelings	40	180
Mushroom gardens	35	180
Food remains	25	200
Cow dung	25	250
Charcoal dust	35	240
Banana mixed with maize 50% + 50%	25	315
Charcoal mixed with banana 50% + 50%	30	265
Charcoal mixed with potato 50% + 50%	35	210
Charcoal + potato + maize + banana @ 25%	25	240
charcoal mixed with maize 75% + 25%	30	240

Figures in table 1 above were generated from experimentations and pilot trials during the study.

gas and compost depend on cow dung as a principal feedstock⁵. Operators produce small quantities for domestic use and for sale to immediate neighbours.

Feasibility of WWE for Income Diversification and Livelihoods

The income generating projects that were focused on during the feasibility study included; operating a pay-toilet; purifying and distributing Water; production of briquettes, production of soil nutrients and the produc-

⁵This is based on the study conducted by Muyiia 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

tion of detergents and biocides.

Operating a Pay-toilet

The pit latrine coverage at landing sites is below 23 percent compared with 90 percent in rest of Buikwe district. This is because of the difficult terrain and soil structure at the landing site which complicates the construction of pit latrines. While this is a sanitation challenge, it presents business opportunities. The few toilets in the areas are used communally at a fee of \$2 per family per month. The collections at the pay-toilet could help in offsetting part of the recycling costs. The daytime population at the biggest landing site (Kiyindi) is 42,000, and night population is 32,000 people. In terms of bio-energy and bio-slurry production, a critical mass of fecal material is accumulated within single units; reducing operational costs of fecal sludge collection. The VIP toilet at the landing site requires regular emptying by cesspool trucks at the cost of \$40 each round of emptying. More than 20 rounds of emptying trips are needed within 6 months. In light of this, recycling the fecal sludge is more cost-effective than the existing practice of emptying.

Energy Generation from Solid Bio-waste

Over 1,500 kg of organic wastes is generated daily (equivalent to 547.5 tons a year) at the landing site. This constitute fish guts, food remains, market waste and other bio-waste which could be recycled for bio-energy (biogas/ briquettes) and soil nutrients.

As mentioned previously, the feasibility of making briquettes has been demonstrated by a medium scale briquettes project at St Kizito High school. The project demonstrates that; i) an educational institution can depend on briquettes for cooking (without firewood being used); ii) cooking for 1100 students needs 20,000 Kgs of carbonized briquettes annually to substitute firewood; iii) By selling 20,0000 Kg of briquettes (each at \$0.24), the production unit earns \$4800 (gross) and \$2155 (net) per year; v) The school saves 25% of fuel costs per year by using briquettes instead of firewood; vii) With capital investment of \$12,250, operational costs of \$1000 and payback period on investment is at 14.7 months. For a smaller scale WWE, women in a SACCO could operate a briquettes production unit with a \$1350 start-up capital and an operating recurrent capital of \$210; totaling to \$1560. With an assumed monthly production of 2000 kg, the profit margin is \$284 and the pay-back period is only 5.5 months. In the country, there are over 40,000 educational institutions that could potentially transit from firewood to briquettes for cooking. The educational institutions are spread across the country and could be accessed for marketing briquettes. The feasibility and viability of use of biogas is demonstrated by the table below.

Given that electricity cost is \$1 for 1 kw/hr: the use of biogas for lighting/cooking becomes a cheaper option. Both biogas and briquettes reduce respiratory complications associated with cooking with firewood; and saves trees/forests. Using carbonized briquettes for institutional cooking requires modification of the cook-stoves (the cook-stoves varies from the energy-saving stoves that use firewood). Organic bio-waste could also be converted into biochar and soil nutrient for organic farming, biocides and disinfectants.

Table 2. Methane production from various feed-stocks

Feedstock	Daily wet feed rate Kg/day	Daily methane production M ³ /day	Kw
Wastewater sludge	16,000	193	100
Food waste	1500	35	18.4
Fish waste	500	108	5.64
Water hyacinth	500	7.7	4
Total gas			129 Kw

Data in table 2 above were obtained from a series of experimentations and pilot trials during the study

Feasibility of Purifying and Distributing Water

Water Quality

The lake water is heavily polluted by impurities caused by storm run-off, waste dumping, animal waste, human waste, agricultural fertilizers, pesticides, abattoir and food waste. The water causes skin irritation, water-borne diseases such as bilharzias, diarrhoea and typhoid. The water turbidity demonstrates its impurities even to the naked eye. Individuals make a living ferrying water from Nabirye well and selling it to the residents at a price ranging between \$0.08-0.26 for 20 liters. Other people boil water and sell it to the residents. Over 40 percent of the 42,000 population have the willingness and capacity to pay for processed/treated water.

Hollow-fiber Membrane Filtration Technology

Proposed water purification is done by a filter whose innovation is based on Hollow-fiber Membrane Filtration technology. It is a gravity-operated filter with a fast flow rate, which can supply several people with clean water in a matter of seconds. Each unit has been shown to last a minimum of 10 years with no replacement parts. The bucket can be prepared locally; the filter combination can be delivered at a low cost to respond quickly in emergency situations (about \$30). To set up a medium scale production of drinking water based on 4000 litres per month: a capital investment of \$2743 is needed. The recurrent expenditure needed is \$365.76. The gross sales from 4000 litres would be 941.2; making a net profit of 575.44. The payback period on investment thus would be 5.4 months.

Production of Organic Detergents and Biocides

Lacto Bacili as a product is a barrier that keeps away harmful organisms (pathogens and pests) from plants. It acts as a pesticide for a variety of plant life. Depending on marketing efforts, the potential demand for *Lacto Bacili* is high for farmers in agricultural areas.

IMO decomposes harmful gases such as hydrogen sulfide and ammonia changing them into odorless gases. It regulates bad smells in pit latrines, animal farms and other environments. The potential market for *IMO* can be found in informal settlements where odors from pit latrines is most problematic. To set up a medium scale production of *IMO* and *Lacto bacilli Biocide* based on 960 liters: capital investment of \$1906.2 is needed. Recurrent expenditure needed is \$1582.6. The gross sales from 960 litres is \$3936; making a net profit of \$2353.4. The pay-back period on investment is calculated to be about 1.5 months. The feasibility analysis made in the foregoing section demonstrates that interventions to diversify women income generating activities are viable and possible. In view of the above, *WWE* could be viable for women provided there is appropriate capacity building measures implemented as well.

Aligning Feasibility of *WWE* with Capacity Building

In light of the above stated feasibility analysis, the comprehensive capacity development requirement for the women can be categorized into four major domains; a) *Technical hands-on skills* needed to operate the various practical aspects of the sanitation enterprises; b) *Entrepreneurial skills* to; i) plan business enterprises; ii) make feasibility assessments; iii) securing start-up capital (credit or other means); iv) investment/profit analysis; v) financial management; managing books of accounts; vi) packaging and branding; vii); advertising and marketing products; c) Human resource management: i) communicate effectively with fellow workmates, partners, ii) customer relations; handling clients and distributors; d) *Enterprise sustainability*: i) investing and re-investing to grow capital; ii) Accumulation of assets and capital; iii) multi-tasking; iv) making basic cost-effective and cost-benefit analyses; v) determination of break-even and pay-back periods.

Capacity Development Needs for Briquettes Production

Developing capacity involves training and securing facilities for; a) *Procuring raw materials and sorting*: cost-benefit analyses of alternative uses of various waste streams; (e.g. could banana/potato peels be used as animal

feeds more economically?); costing source of wastes; costing the transportation/delivery; does it make business sense? Carbonizing and crashing carbon char before transportation (to reduce waste bulk); *Sorting waste*: types of waste; separating organic from inorganic waste; engaging households/agents to sort waste at source; sorting at carbonization site; segregating different streams of organic waste for phased carbonization; determining which waste produces which quality of briquette; b) *Carbonization*: drying waste; types of carbonizers; processes of carbonizing different streams of bio-waste; c) *Crashing of bio-char*: types of crushers; levels of crashing; crushing carbon from different bio-waste streams; d) *Mixing the char*: types of binders; mixing char with binders; mixing char from different waste streams; types of mixers; e) *Extruding briquettes*: types of extruders; types of briquettes; purposes and efficiency levels of different briquettes; producing honey combs/stick briquettes; f) *Drying briquettes*: types of driers; duration of drying; appropriate standards of drying; g) *Packaging and storage*: ideal packaging approaches; storage and transportation of briquettes; risks involved in poor packaging, storage and transportation

Capacity Development Needs for Biocides and Disinfectants

This would involve training and securing facilities for; a) *making lacto bacilli*; i) preparing milk and rice water; ii) mixing appropriate ratios of milk and rice water; iii) preparing molasses solution; iv) mixing the milk and rice water solution with molasses solution in right proportion; v) filtering and sieving of the mixtures/solutions; vi) determining duration of storage before marketing; vii) packaging, branding for marketing; b) *making IMO*: i) preparing the posho mixture; ii) preparing the molasses mixture; iii) culturing the mixture of posho, molasses and water; iv) determining duration of storage before marketing; v) packaging, branding for marketing; vi) purifying/distributing water.

Capacity Development Needs for Water Purification

This involves training and securing facilities for; a) determining water quality: and color, turbidity; b) using low-tech tools/approaches to verify water quality; c) using hollow-fiber membrane filtration technology; d) maintenance of filtration tools; e) packaging and branding of water for marketing

DISCUSSION

Feasibility studies demonstrate the great business potential and livelihood opportunities for women who engage in WWE for income generation. However, the existence of opportunities alone is not enough to ensure a practical application of WWE deployed as income generating activities. These opportunities can only materialize when social and cultural barriers are minimized.

Intensity of Cultural and Gender Stereotypes

Cultural beliefs and gender norms are embedded in taboos and routine practices. Meeting a woman on the way to the lake or having a woman on the boat is associated with a low fish catch (Madanda 2003). Among the Sukuma, Jita and Kerewe and Luo communities, menstruating women going anywhere near the lake contaminates the lake and reduce its productivity (LVFRP/SEDAWOG 1999). As pointed out by Tindall and Holvoet (2008), men are considered users and managers of fisheries resources. The phrase ‘men catch fish and women sell fish’ (Mojola 2011) reflects the complexity of these gender relations that would impede increased female participation in productive activities in the area.

Socio-economic Inequities

The social reproduction obligations assigned disproportionately to women restrict their overall participation. To begin with, there is a difficulty in balancing productive roles (income generation) with reproductive roles (housework) (Kusakabe et al. 2006). This is aggravated by the natural routine of fishing schedules (such as night fishing) which influence household patterns and family responsibilities. A typical housewife and mother may

not be afforded flexible schedules. Women are limited to buying and selling fish which are not in demand in the lucrative fish industry and they cannot negotiate the types of fish to sell (Geheb et al., 2008). They also fall victim to state regulations on the type of nets to use and are subject to arrest for trading in small-sized fish; presumed to have been caught using small nets (Medard 2012). This often follows as a failure of enforcement officers to apprehend men who use illegal nets. Low levels of education further affects women wellbeing, where many have not completed secondary or primary school.

Inadequate Social Networks for Enterprise Development

The type of business an average woman could start include petty trading in fish and liquor sales. As observed by Resurreccion (2008), the few successful women leaders are often the wives of male leaders at the landing sites. Women who are supported are more able to operate productive enterprise. Unfortunately, changing fish stocks and growing competition in the fisheries industry reduce the contribution that could come from their existing social networks. Consequently, women are left with one survival option; transactional sex whose risks are considerably large. Because of social iniquities, women lack the bargaining power to refuse sex demands or to negotiate safer sex (Kwena et al, 2012). Starting businesses also calls for start-up capital, which an average woman most likely will not have.

WWE and the Gender Perspective

In the context of social, cultural and economic iniquities at the landing sites, WWE offer great livelihood opportunities for women. Valuation of waste is influenced by gender because what looks like junk and “dirty” to men can be turned into something valuable by women. How men and women perceive discarded materials may depend more on who they are than on what they do. Men may take longer to consider it a worthwhile exercise in re-using and recycling household bio-waste materials.

There are also marked gender-based preferences related to public health and environmental conservation. This view is in line with the Social Construction of Technology (*SCOT*) notion of *interpretive flexibility* (Doherty et al 2006). Depending on the social circumstances of development, technology can generate diverse and evolving expectations among various social groups. Women who are usually the victims of epidemics have preferences on types of services and products they would like to develop in their communities. Water safety and energy accessibility are central areas of interest for them. Incidentally, at the Beach Management Unit in the landing sites, women delegates constitute 40% of the membership. This creates an opportunity for the development of supportive policies on waste management approaches and appropriate technologies at the landing sites.

Developing Capacity of Women for WWE: Tapping into Opportunities and Overcoming Barriers

In light of the gender, social and economic inequalities facing women in fishing communities and in light of the feasibility analysis of WWE, the following section examines what it entails to develop capacity of women to engage in WWE and tap into potential opportunities. It also explores the associated barriers to realizing these opportunities.

Waste management at the landing sites calls for frameworks for enterprise development for women who lack alternative business networks. Currently micro-enterprises in the waste sector in Uganda are initiated, operated and managed by men even when women are widely active in waste picking and salvaging. It is imperative to ensure that men do not easily infiltrate WWE to edge out women. In the absence of innovative programs for women empowerment, WWE will most likely be engulfed in the prevailing forces of competition and inequality.

There are important gender-related questions that are critical for the success of WWE. 1) Could women-owned enterprises afford the higher investment? 2) Are WWE able to generate a higher work volume to pay for the start-up capital? 3) Could women-owned enterprises be as aggressive as men-owned or mixed enterprises? 4) Do women have the managerial expertise required for a greater volume of work? 5) How could the new work schedules rhyme with women’s domestic responsibilities in this cultural context? 6) are there health risks en-

tailed in WWE that affect women? If yes, how could they be addressed? Providing answers to the above questions is likely to mitigate existing forces of competition and inequality in a society; forces that reinforce or even increase women's socio-economic disadvantage. Capacity building for women in WWE calls for gender-specific analysis of how available waste-related resources are valued and used. Various perimeters should be used to conduct assessment studies and participatory planning, implementation and monitoring of waste management projects. The gender-specific analysis should a) examine the play of prevailing forces of competition and inequality; b) develop participatory consultation and decision making processes; c) promote access to start-up capital for WWE in general and for new technology; d) promote access to information and training and; e) locate the WWE in places accessible to women considering their domestic responsibilities. Part of the questions above could be addressed through; a) the establishment of institutional frameworks for supporting women engagement in WWE; b) establishment of Women SACCOs to widen their Social Networks; c: social norming for health and environmental sustainability:

Institutional Frameworks for Developing Capacity in WWE

The role of government and development agencies is to design gender-specific programs supporting the introduction of new waste recycling frameworks. Already, the collection and disposal of solid waste at many of the landing sites is privatized; meaning that a system is in place for Public-private partnership (PPP).

Beach Management Units (BMU)

This is a community-based fisheries management agency formally instituted by government. This statutory instrument provides legal empowerment for the BMU to plan for development and management of the fisheries in partnership with local governments. By legislation, at least 40% of members of BMU at Kiyindi landing site must be women. This potentially addresses the gender mainstreaming aspect by providing at least a base of women representation.

Role of Government, Private Sector Agencies and Academia

The potential role of relevant government agencies in capacity building for women include; a) streamline policies and provide relevant WWE infrastructure; b) coordinate appropriate stakeholders; c) provide national and global networks to support the WWE initiatives; d) enhance opportunities for women groups to secure start-up and scale-up capital for small and medium enterprises. The private sector contribution could include; a) supporting the commercialization of WWE; b) promote marketing of WWE products; c) coordinating start-up and scale-up financing; d) coordinating training and financing initiatives at grassroots levels. The academic and research centers' contribution to capacity building may include; conducting research for evidence-based policy-making; development of scientific and technological innovations and; production of skilled manpower for WWE development. For purposes of capacity building, the above agencies have the capacity to promote social networks for facilitating women engagement in WWE.

Women SACCOs in the Context of the Social Network Perspective

As alluded to previously, capital from existing social networks of friends, parents, relative's acquaintances, spouses or sexual partners are not adequate nor sustainable for WWE. Social networks are relationships that exist between individuals/groups, the ties holding them together and resources at their disposal (Borgatti & Ofem 2010). The components of a social network are; a) actors (individual women or groups of women); b) the ties that link them together; and c) the resources at their disposal. The resources within a social network include ideas, information, social support and financial support (scott 2012). A central feature of social networks is the flow of social capital that can be leveraged to the group benefit (Borgatti, Mehra, Brass and Labianca 2009). Social capital involves communal use of resources, collective energy, moral support, interpersonal trust and reciprocity (Kadushin 2012). The principle of social network resource sharing holds that individuals and groups are

influenced by the kinds of ties or connections existing within their communities. In the context of women SACCOs in the landing sites, individuals are expected to make a contribution. Since ties are pipes or paths through which resources flow, it is assumed that the more relationships exist, the more access actors have to the resources within the network (Borgatti and Ofem 2010). Accordingly, the bigger the membership in specific SACCOs the more potential ties; and the more possibility that resources move quickly compared with networks that have fewer ties. As long as individuals or groups depend on the network for their wellbeing, they are constrained in adopting or rejecting agreed norms and practices. Different network structures can confer benefits, opportunities and/or constraints for those involved (Borgatti & Ofem 2010). Requirements for initial investments in WWE are occasionally prohibitive (Walekhwa 2009) particularly for marginalized women at the landing sites. It is therefore presumed that the funding could be secured through Women SACCOs. Start-up and scale-up support is necessary to boost local capacities and initiatives with technically viable initiatives, which otherwise would not have been afforded (Oberlin & Sza'nto 2011). Capacity building programs on WWE should focus on; a) identifying types of resource exchanges that are crucial for women in fishing communities; b) how the resources could circulate within the women's social networks and; c) positioning women to influence resource exchange within their networks. Within the fishing communities, formation of strong social networks anchored on women SACCOs could be a central pillar in addressing cultural/gender stereotypes and social inequities. As Bruner (1990) points out, an endangered society is one where alternative narratives cannot be scripted and whose members can no longer change the stories they tell themselves. In such cases, communities are held hostage by a sense of fatalism. Women social networks could be used to demystify incapacitating behavioral patterns and reverse trends that are considered unalterable.

Formation or consolidation of women SACCOs is therefore the genesis of social networks that are likely to enhance mutual support, collective learning and shared experiences. Among other things, formation of SACCOs is likely to safeguard women's economic interests against men who may look at WWE as lucrative to dominate WWE and edge out women. In the event that WWE is operated by powerful women SACCOs, they are likely to involve or employ other women. For sustainability of WWE, women laborers are more likely to take greater effort and a longer-term commitment to waste-related work. Men may leave at the earliest opportunity for higher-status occupations because they seem to have many working options. WWE is likely to elevate the status of women within the context of waste-related work. Workers in areas of waste collection (regardless of gender) experience disrespect and outright scorn from fellow-citizens because handling untreated waste is considered demeaning. By earning their own income through WWE, it is likely to usher in new-found self-confidence and financial autonomy. The focus of sanitation initiatives should not be only on business and entrepreneurship, but on health and environmental considerations. In a way, social networks contribute to self-efficacy and resilience among women who have been marginalized across most societies for a large part of history.

Social Norming for Resilience to Social and Environmental Challenges

Social norming is a psycho-social approach that capitalizes on group dynamics (social cohesion, peer influence, group consensus; communal decision-making, social pressure and social capital). Social networks act as change agents for individuals to acquire and sustain ideal practices. Given that individuals behave and act in socially acceptable ways, modifying their actions and behaviors can best be achieved through influencing behavior of people in their social networks. This approach could be used for initiating and sustaining, zero littering and sorting waste at the source (Nye & Burgess, 2008). Social networks are instrumental in developing efficacy and community resilience for coping with environmental related challenges (Rowson et al., 2010). For women in particular, social norming could address stigma created by years of social marginalization. By promoting social identity and collective value systems, sustainability is incorporated as a guiding principle (Rabinovich et al., 2010). Conceptually, members of a social network start by complying with group norms to avoid a feeling of guilt, or to ensure that they 'fit in'. With time, they develop 'intrinsic' motivations to sustain the practices that conform to group norms (CCCAG, 2010). Social Norming is a typical bottom-up horizontal intervention

for handling long-term behavioral change initiatives, which is a departure from structured top-down cognitive-rationale approaches. The latter is typical of vertical interventions ideal for short-term rapid responses for addressing epidemics or natural disasters. The cognitive-rationale approach presumes that providing knowledge and information is enough for individuals and groups to adopt desirable behaviors and practices. This may not always be the case particularly in the absence of socio-economic incentives or other internal motivations within individuals or groups to comply with ideal norms and practices.

CONCLUSION

In light of the gender, social and economic inequalities facing women in fishing communities, this study investigated; 1) prospects for diversifying their income and livelihoods; 2) opportunities and barriers for their economic empowerment and 3) the feasibility of WWE as alternative income sources. Findings revealed that the three aspects of WWE (renewable energy production, safe water provision and production of biocides) were feasible and could make rational sense even in the absence of social-benefit accounting. Baseline studies suggest that the business community at landing sites have the willingness and capacity to meet costs of sanitation services. The products of WWE (biogas, briquettes, soil nutrients, biocides and disinfectants) have a ready market in other high-density population areas. This paper outlined various capacity building needs for the meaningful engagement of women in the technical, managerial and financial operations aspects of WWE. Capacity building requirements were also examined in the context of the feasibility analysis. It is noted that through their social networks, women could provide alternative waste management frameworks anchored on enterprise development. Besides the need for income, women are well positioned to care for the health environment within their communities. Engagement of stakeholders in waste management through the application of social and economic incentives is an innovative approach within the framework of Social Construction of Technology (SCOT). Success of the waste management framework calls for the integration of technological, social, and economic approaches for sustainability. Particularly, it requires the buy-in of target communities. It is also noted that building capacity for the women to engage effectively in WWE calls for; a) gender-specific analysis of; prevailing forces of competition and inequality; b) determination of how available waste-related resources are valued and used; c) development of participatory consultation and decision making process; d) promotion of access to information and training; e) location of WWE in places accessible to women considering their domestic responsibilities and f); promoting access to start-up and scale-up finance. Government, academia and development agencies could play a central role in capacity building and in promoting access to needed start-up finances. The development agencies could also play a central role in setting up social networks anchored on women SACCOS as pillars for enhancing women engagement in WWE. This paper has highlighted social norming as a strategy for; 1) consolidating the internal dynamics and operation of the SACCOS; 2) promoting community resilience for coping with environment related challenges; 3) promoting self-efficacy among women for meaningful engagement in WWE against the background of gender and cultural stereotypes and inequalities.

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