University Education and Waste-to-Wealth Entrepreneurship for Youth Employment in Uganda

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Abstract

While universities are mandated to teach, research and do community outreach, studies reveal that typical university communities live in relative isolation where research is more basic than applied. This study focused on; 1) determining how WWE could be fostered through linkages between universities and external agencies (communities, public and private sectors); 2) establishing how universities' resources could be optimized to promote research and capacity building for WWE. The dimensions of WWE studied were; 1) Technical & Business Models; 2) Capacity building; and 3) institutional frameworks. Baseline studies were conducted in which qualitative and quantitative data was collected through questionnaires, interviews, documents analysis. Experimentations were carried out whereby Laboratory tests on Bio-methane Potential (BMP) for different biomass types was conducted. A complete chain of briquettes production and consumption has been successfully piloted at St Kizito High School in Namugongo, near Kampala. The 20,000 kg of briquettes produced (from municipal bio-waste) by students monthly are used to cook in three schools whose total population is 2000 students. With an average net profit of $ 3000, the project makes business sense even in absence of social-benefit accounting. Based on start-up capital of $ 12,250, the payback period on investment is 14.7 months. Bio-char (from carbonized waste) and briquette-ash are used as organic fertilizers and biocide in vegetable gardens at the schools. New pathways for municipal waste management based on stakeholder engagement and entrepreneurship are demonstrated; departing from the conventional waste collection and disposal models. This circular enterprise which enhances Food, Agriculture, Biodiversity, Land-use and Energy (FABLE) nexus will scale-up to incorporate non-student communities (youths/women), private waste-collectors and entrepreneurs. The application of entrepreneurial models for engaging students in green enterprises integrates technological, social, economic and governance dimensions for promoting municipal sanitation, environment; energy and food security.

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Introduction

Waste-to-wealth Enterprises (WWE) refers to the processes of upscaling and commercializing waste recycling. This study focuses on recycling the organic tracks of waste for production of briquettes, organic fertilizers and biocides. Conceptually, bio-waste recycling has socio-economic and environmental benefits such as: a) creating income generating opportunities for the youths and reducing unemployment; b) substitution of firewood/charcoal with bio-energy; c) promotion of organic farming; d) improvement of municipal sanitation. In light of the above, bio-waste recycling harnesses the Food, Agriculture, Biodiversity, Land-use and Energy (FABLE) nexus. The growing population in Uganda generates increased demand for food, water, energy, space (accommodation) and jobs. Attempts to satisfy the demands generate multiple vulnerabilities arising from; 1) reclamation of wetlands and forests for farming and accommodation; 2) depletion of soil nutrients and use of chemical fertilizers, biocides and disinfectants; 3) energy poverty leading dependency on charcoal and firewood for cooking/heating by 90% of the population; 4) Poor sanitation in high-density urban settlements; 5) pollution (of land, wáter and air); 6) unemployment and Poverty. The public sector agencies (local government, central government, ministries) are constrained financially to deliver core services to needy communities. Specifically, less than 10% of households are centrally connected to sewer lines and approximately 40% of municipal budgets are used to collect only 30% of solid waste. The remaining solid and liquid waste pollute wetlands and natural water bodies. Between 1997 and 2000, European Union banned fish imports from East Africa on grounds of water pollution. The polluters could be recycled for fuel and fertilizers. However, development of large-scale recycling schemes is still at an embryonic stage (Parawira, 2009). This is because recycling is done informally by groups that choose to pick plastics and metal scraps which they sell to recycling factories. The commercial value of bio-waste is not yet understood widely. Engaging stakeholders in resource recovery across the food, energy and water and eco-system nexus is therefore critical to address the natural resource loops. The products from recycling include; bio-fuels (biogas, briquettes), organic fertilizers, biocides and disinfectants; and animal feeds/nutrients. 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, supportive policies, subsidies and locally available materials.

Conceptual and Theoretical framework

Whereas domestic, agricultural and industrial waste is rich in nutrients and energy; and while recycling technologies exists, waste recycling is still at a small scale. Baseline surveys revealed that upscaling recycling is hampered by; a) poor quality plants and poor material choice and inexperienced contractors; b) heavy dependence of projects on donor subsidies; failing to survive beyond pilot phases; c) absence of entrepreneurial models to attract private capital; ignorance about business prospects of recycling; d) Inadequate managerial and entrepreneurial skills; e) non-streamlined policies on recycling; f) cultural and socio-psycho sensitivities on consuming some products of recycling; g) absence of inter-sector linkages and partnerships on waste recycling; h) lack of start-up and scale-up capital for potential entrepreneurs. New pathways based on entrepreneurship and partnerships are needed to attract private capital towards bio-waste recycling. Recycling as an innovative model of waste management can only be promoted when environmental, social and economic incentives are demonstrated; and capacity built for stakeholders' active

engagement. Adoption of bio-waste recycling could be conceptualized through the ***Social Construction of Technology (SCOT) Model***. It stipulates that technology works in a social context (Pinch & Wiebe 1987). Social structures influence and determine acceptability, adoption/rejection and/or modification of a technology. Specifically, communities are not passive receivers of technological innovations; they should participate in order to influence its success. It was presumed that; a) University community (students and staff) would be the primary champions for upscaling WWE as long as they have requisite technical, financial and managerial skills; b) the University community are positioned to engage diverse stakeholders to participate in WWE. The stakeholders include i) Private Waste Collectors (PWC), ii) grassroots urban communities (youths, women, others); iii) Civil Society organizations (CSO); iv) urban authorities; v) Public sector agencies and; vi) academia. This study aimed at determining how University Education could promote Waste-to-Wealth Entrepreneurship for Youth Employment in Uganda. The following questions guided the study; 1. How WWE could be fostered through linkages between universities and external agencies (communities, public and private sectors); 2) In which way could universities' resources be optimized to promote research and capacity building for WWE?

Materials and Methods

The Baseline Studies: Baseline studies were undertaken to generate data on; 1) existing knowledge, attitudes and practices on bio-waste recycling; 2) existing practices on waste recycling as business; 3) opportunities and barriers for waste reuse/recycling; 4) existing and prospective Information, Education and Communication (IEC) structures on bio-waste recycling; 5) capacity building needs; and 6) start-up and scale-up requirements (financial and technical) for bio-waste recycling; 7) existing costs of energy (firewood, charcoal, electricity, etc.); 8) existing and potential demand for briquettes; 9) distribution and marketing structures of charcoal and firewood; 10) needs for start-up and scale-up financial facilitation. Qualitative and quantitative data was collected through questionnaires, interviews, documents analysis and focus group discussions. The respondents included students, grassroots urban communities, business community; opinion leaders, local government officers and officers of local civil society organizations (CSO).

Experimentation and viability tests; 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 domestic waste, market waste, compound waste, agro-waste, animal dung and saw dust. Weight loss of different feed-stocks in process of drying and carbonization was established to determine weight/volume loss of bio-waste during briquetting. It a measure of how many Kgs of briquettes secured got from specified volumes of feedstocks (bio-waste). Heating and cooking duration of briquettes from specific feedstock was measured and established. Through a series of experimentations and trials, energy-saving cookstoves at St Kizito High School were modified to ensure that briquettes were used in institutional for cooking big volumes of food.

Proof-of-Concept Pilot Projects: A complete chain of briquettes production and consumption was experimented and piloted at St Kizito high school in Namugongo. The following components were established; i) waste sorting at source ii) carbonizing bio-waste near source; iii) crushing the bio-char; iv) extruding bio-char into briquettes; v) solar-drying the briquettes; vi) packaging and branding briquettes for distribution and marketing; vii) using briquettes for

commercial cookery/baking; ix) use of briquettes for household cooking/baking; x) designing institutional cook-stoves that use briquettes; xi) smart agricultural units that use biochar (and ash from cook-stoves) as fertilizers and biocides. Smart farming units were set-up to test briquettes-ash as fertilizer and biocide.

Training and skilling: Short training programs were designed for students and non-school communities in; ***a) technical aspects of briquettes production*** (Sorting waste: carbonization: crashing bio-char; mixing the char binding: extruding briquettes; solar drying of briquettes: Packaging and storage); ***b) Entrepreneurial skills*** (business planning, feasibility assessments, book keeping; packaging and branding, advertising and marketing; human resource management; cost-benefit analyses. Attention was given to raw material procurement; to enable participants assess alternative uses of various waste streams to determine the cost of securing them. For instance, given that banana/potato peels are alternatively used as animal feeds, cost of securing them could be higher. Using the approaches described above, it was possible to generate data on the key objectives of the study

Findings of the study

The key findings from the study are presented in both numerical and descriptive formats.

Findings from the baseline studies

Waste collection patterns; following the privatization of waste collection, companies of varying sizes engage in waste collection and disposal; whereby homesteads pay for collection services. This partly contributes to more efficient waste collection in well-to-do residential areas than in the poor areas. Besides, poor road networks in the informal settlements reduces accessibility by waste collection trucks; leading to piling of waste. Over 40% of municipal budgets in Uganda are committed to collecting only 30% of solid waste. The remaining solid and liquid waste pollute wetlands and natural water bodies. Over 80% of the waste is organic which could be recycled into fuels and fertilizers.

Knowledge, attitudes and practices on bio-waste recycling; There is absence of streamlined policy and centrally organized recycling schemes. Focus of informal groups is put on metallic and plastic materials because the value of organic waste is not known by many. The model used by private waste collection companies is one of collection and disposal; they do not process waste for value addition.

Existing cooking and heating energy: given the high costs of electricity, LPG and paraffin, over 90% of urban households depend on firewood and charcoal for cooking/heating. Over 80% of educational institutions, ceramic companies and clay-works depend on firewood for cooking/heating. The distribution chain and usage of briquettes do not vary much from that of charcoal; meaning that there could be smooth continuity.

Findings from experimental studies

Waste-to-energy conversion of different bio-waste streams: Experimentation of the heating intensity and burning durations of briquettes made from diverse bio-waste reveals that different bio-wastes vary as shown by the table below shows the relative

Table 21: Weight loss, heating intensity and burning duration (in minutes) of briquettes made from different bio-waste streams

Composition	Weight loss during recycling	boiling time for water; 10 littres	Burning duration
Banana peelings	83%	20 minutes	330 minutes
Potato peelings	77%	30	270
Saw dust	36%	35	210
Maize cobs	75%	25	300
Irish peelings	77%	40	180
Mushroom gardens	50%	35	180
Food remains	70%	25	200
Cow dung	65%	25	250
Charcoal dust	0%	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

Data in table 1 above were generated from experimentations and pilot trials during the study. The table suggests the following;

Weight loss: It is practical to carbonize waste near its source to reduce its bulk; and reduce transportation costs. Equally, it is economic to mold briquettes at locations near markets to reduce breakages over long distance transportation.

Boiling intensity and burning duration: This data guides different consumers on the kind of briquettes to use. It may also dictate the quality and price of briquettes made from different bio-waste streams; and the money to pay for collecting various types of waste.

Table 22: Institutional consumption of briquettes and waste generation in Kampala

	Aspect	Values	Remarks
	Briquettes production/consumption		
1	Briquettes used St Kizito; population of 1100	20,000 kg a year	$ 0.24@ ($ 4800)
2	Costs saved by school in using briquettes	25%	
3	People employed by the production unit	12	
4	Potential average market size of briquettes	40,000 schools	$ 86,200,000
5	**Waste generation in Kampala city**		
6	Waste generated in Kampala city monthly	90,000 tons	
7	Fraction collected by the city	27,000 tons	30%
8	Fraction dumped in non-authorized places	63,000 tons	70 %
9	City expenditure on waste collection	40% of budgets	
10	Organic waste generated monthly	72,000 tons	80% of generated
11	Weight loss on drying & briquetting	61200 tons	85%
12	Potential Monetary value of the waste after carbonizing	$ 0.24 @ kg x 61200 tons	$ 14,688,000
13	Workers that could be employed by the briquette production in Kampala alone	200,000	

Note: figures in table 1 above show that waste generated in Kampala city alone could meet 17% of the energy demands of the 40,000 schools in Uganda. The rest of the needed waste (83%) could be got from other urban centers and from villages.

Table 3: Business model for monthly production of briquettes

	Capital investment (on equipment/infrastructure)	***USD***	
1.	***Equipment: factory-scale briquettes production (20,000 kg)***		
	Electric sheaving machine	300	
	Carboniser	1700	
	Production unit	5000	**12500**
	Electric briquetting unit	3200	
	Solar drier	2000	
	Packaging and branding devises	300	
2.	***Equipment Small scale briquettes production***		
	Manual sheaving machine	134	
	Manual crushers	186	
	Manual briquetting machine	400	**1020**
	Packaging and branding devises	300	
3.	***Operational costs based on 20,000 Kg***		
	Securing; sorting Bio-waste	600	
	Labor costs	1000	
	Costs of binders	150	
	Power (electricity/diesel)	210	**2800**
	Monthly machine maintenance costs	200	
	Packaging and distribution cost	140	
	Management/administrative costs	200	
	Statuary tax	300	
4	***Briquettes sales based on 20,000 Kg***		
	Gross sales from 20,000 Kg at $ 0.20 per Kg	4000	
	Net profit: gross sales minus total operational costs **4000-2800**	1200	

Notes: the table suggests that start-up capital for factory-scale production of 20,000 Kg requires is $ ***15,300*** (capital investment ***$12,500***; operation costs ***$ 2800***). With the net profit of $ 1200 earned monthly, the payback period is 12.5 months (***15,300 divided by 1200***). Capital investment for small scale briquettes production is $ ***1020***. This can be afforded by individuals and urban youths and women groups.

Processing and supply of bio-char: Individuals and groups have the option of carbonizing and crashing bio-waste (using manual devices) and supplying it to factory-scale briquettes producers who have access to institutional markets.

In the light of the above presentations, there are great business prospects for recycling of municipal waste and the prospects depend on the nature of capacity building initiatives. The section below discusses the issues, opportunities and what it entails to scale-up the waste to wealth enterprises for promotion of municipal sanitation.

Promoting WWE through linkages between Universities and external agencies

The roles of key stakeholders are determined by their interests and expectations from waste recycling.

Government and civil society agencies: their interest lies in environmental preservation and community welfare. Their prescribed role includes; a) streamlining policies in support of waste recycling; and provide relevant WWE infrastructure; b) coordinating key stakeholders; c) providing local and global networks; d) coordinating start-up and scale-up capital (credit) for small and medium enterprises; e) coordinating and financing training programs at grassroots levels.

Urban authorities: Given their big expenditure on waste management (about 40% of budgets) they are in position to invest in recycling schemes to reduce the expenditure. Besides, recycling provides employment and livelihoods opportunities to urban communities.

Private waste collectors: Some of the companies are low-resourced and occasionally end up dumping bio-waste to non-designated dumping sites and landfills due to the costs entailed. Recycling not only attracts additional income, but also reduces transportation costs.

Academia: They are positioned to develop research for evidence-based policy-making and also introduce scientific and technological innovations that promote bio-waste recycling.

Entrepreneurs: As long as the viability of bio-waste recycling as business is demonstrated, entrepreneurs are positioned to invest in recycling and avail the needed private capital into waste management schemes.

Partnerships with government and private sector agencies: In 2017, NDU organized a business dinner to initiate an academic Public private Partnership (APPP) focusing on environmentally sustainable development. The university has also conducted seminars, workshops and conferences involving line government and private sector agencies (National Environment Management Agency (NEMA); National Agricultural research organization (NARO); Kampala Capital City Authority (KCCA); National Water and sewerage corporation (NWSC); Uganda National Biogas Agency (UNBA); German-based GIZ; and others

Grassroots communities: The piles of waste that accumulate in the areas where low-resourced communities stay transmit diseases and create other sanitary challenges. As already pointed out, low resourced residences are not effectively served by waste collectors. The role of the communities would be: i) waste collection; ii) sorting; iii) providing manpower for carbonizing, briquetting, drying and marketing. In so doing they earn income, improve livelihoods and reduce the sanitary challenge in their midst.

Optimization of Universities resources to promote research and capacity building for WWE

Multi-disciplinary integration for WWE in higher institutions of learning: Premised that WWE has technical, social, and economic & policy dimensions, expertise from diverse disciplines is pooled and integrated at Ndejje University. Inter-faculty seminars workshops are conducted and the cords that link the different disciplines were identified and connected. Each faculty brings to the table diverse components that are harmoniously integrated into technical, business and managerial models

Figure 1: Framework for multi-disciplinary integration for WWE

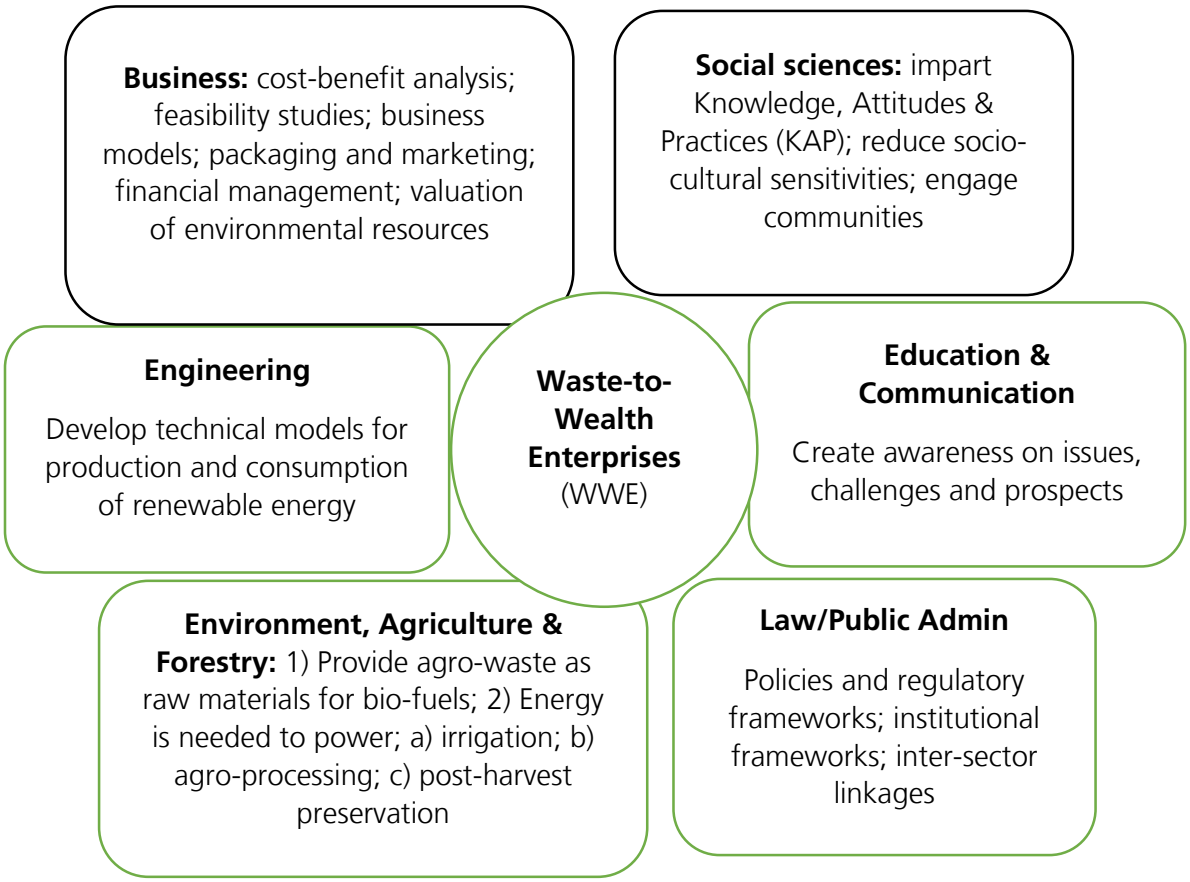
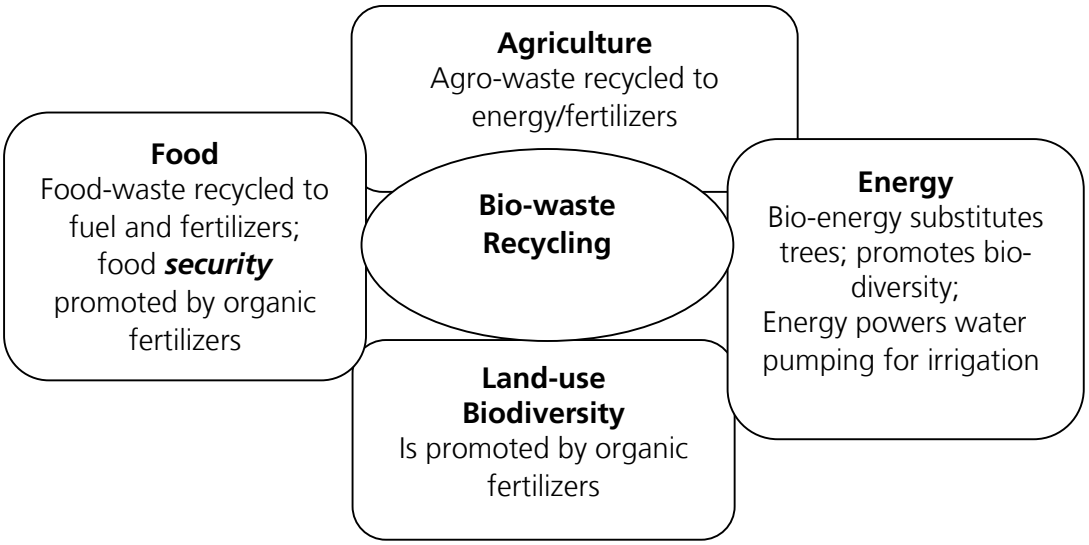


Figure 2: Bio-waste recycling along the Food, Agriculture, Biodiversity, Land-use and Energy (FABLE) nexus



Capacity building requirements for engaging stakeholders in recycling: Capacity building is perceived two dimensions; a) providing technical, managerial and entrepreneurial skills to operate recycling schemes; b) providing opportunities for start-up and scale-up capital.

a) ***Skills for operating recycling schemes***; these are developed along three major domains; i) Technical hands-on skills needed to operate the various practical aspects of bio-waste recycling; ii) Entrepreneurial skills; c) personnel development and Enterprise sustainability. Multi-disciplinary programs and projects were developed at Ndejje University to integrate expertise of natural and social scientists. Curriculum on renewable energy training at the University has aspects of waste recycling. The curriculum is modified and used in training communities in waste recycling. Interactions between students, faculty and community are promoted through the ***Block-placement initiative***. During recess, students are placed in rural and urban homesteads to share insights on common community challenges (energy, sanitation, health, agriculture, others). This is designed to open up meaningful interactions with communities, the students learn from communities and they also introduce social and technological innovations in areas of sanitation, health, agriculture, waste recycling and others. In the process, they analyze issues and challenges in communities and come up with solutions to some of the common problems through participatory approaches. At the level of a high school, Students at St Kizito High school take two hours of formal training per week (scheduled after classes). Some individual students often extend the study time at leisure. Briquettes are used at the kitchen and also sold to parents, teachers and at the church. The model has been successfully piloted in two primary schools, two high schools, one university and one college. The products are also exhibited in trade fares, conferences, workshops and other fora. There are on-going arrangements to intensify Information, Education and Communication (IEC) programs and materials to create awareness and to reduce socio-cultural sensitivities constraining waste recycling. Two companies have been established following the pilot project at St Kizito high school; 1) WEYE; an enterprise that empowers urban youths, women and girls to develop renewable energy as business; and Summit green company LTD.

Opportunities for start-up and scale-up capital: The case study of St Kizito high school provides information about the technical and business prospects of factory-scale briquettes production. It demonstrates models that could be adopted to commercialize briquettes production. This could be replicated to other educational institutions, prisons, hospitals, hotels/restaurants; clay and ceramics industries. Given educational institutions are over 40,000; demand market for the briquettes could be insatiable. Unfortunately, efforts to obtain credit from financial institutions to upscale briquettes production are constrained by lack of understanding of the briquettes production enterprise by the financial institutions.

Discussions

The fact that youths constitute over 75% of the population in Uganda, means that they are key stakeholders in all sectors of national development. They ought to be skilled in various aspects of production and sustainability. Universities are well positioned to use their teaching and research facilities to prepare the youth for their rightful roles in environmentally sustainable development.

Centrality of WWE in addressing social and environmental challenges

While global demand for energy grows, reserves of non-renewable fossil-energy declines. Whereas domestic and agro-industrial waste is rich in energy and while recycling technologies exists, factory-scale recycling has been lacking. Municipal 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. Barr (2005) argues that 'localization' of environmental action to everyday lives could have a significant positive impact on recycling schemes and participation rates. The typical waste management model in Uganda, based on collection and disposal, is increasingly becoming obsolete because of the mismatch between demand and resource availability. On average, municipalities serve below 50% of their targeted population6. The widening demand-supply gap calls for alternative management models that integrate technical, social, economic and governance dimensions. This is because fixing urban sanitation challenges goes beyond technology, equipment and physical infrastructure. For instance, while landfilling keeps waste away from homes, they have secondary effects on global warming through methane gas emissions (Scanlan, 2005). Projecting waste flows and moderating their impacts on the environment should be based on a multi-criteria decision-making (Oyoo et al 2013; Scheinberg et al., 2011). In light of the challenges, engaging stakeholders in addressing natural resource loops and urban sanitation challenges is essential.

The youths and Universities in Upscaling Green Enterprises in Uganda

In light of social and environmental vulnerabilities, promoting resilience among communities calls for well structure capacity building programs, development of synergies and inter-sector partnerships between Academia, Public and

[6] Financial 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

private sector agencies. In many developing countries, Academia-Public-private Partnerships (APPP) take long to grow into national trends (Sutz 2005). Promoting APPP is one of the innovative pathways that could be adopted to ensure that financial, human and technical resources of key stakeholders converge to support green economies. It is presumed that socioeconomic incentives (based on business models) coupled with appropriate institutional frameworks are key in attracting key stakeholders towards green enterprises. There are big prospects for youths' engagement in green enterprises based on ***Resource Recovery and Reuse (RRR)*** along the FABLE nexus. Conceptually RRR relies on leveraging private capital to achieve commercial and social value.

Incentives for youths' engagement in green enterprises should rotate around real/potential demands for the products of RRR. With appropriate orientation and capacity building, young people are positioned to be at the center of the ***Circular economy***. The propagation of the 'Circular Economy' is a transition; a) from the traditional social-welfare costing (met by public funds) to private sector financing (based on revenue generation); b) from social-benefit accounting to cost-saving and cost recovery); c) from bio-waste collection/treatment and disposal towards processing and commodification; d) from single-agency projects to innovative partnership that focus on scalability and sustainability. The success of youths' engagement in green enterprises depends on viable business plans that optimize recycling and reuse market. It also thrives on creative financing mechanism that avail start-up and scale-up capital to individuals/groups that need support. Young people are generally not well endowed with financial resources and they need support for start-up and scale-up capital to operate RRR. There is also need for investment in market research and in bankable business models for cost recovery. Presumably, savings accrued from RRR can finance small and medium enterprises. RRR could reduce public expenditure on social services. The savings that are made could be re-invested in financing SMEs operated by the youths. In this way, the 'Circular Economy' is likely to transform challenges and vulnerabilities into opportunities for business, Jobs and livelihoods for young people. At the same time, the projects would supplement efforts of the public sector as it struggles to bridge service delivery gaps. A key component of WWE is capacity building for stakeholders through training and creative financing models. It calls for demonstration of scalable innovations as a value proposition to stimulate business thinking in the interface of food, energy, water and eco-systems. One of the central pillars of training is the enhancement of synergies and multi-disciplinary integration in schools, colleges, universities and research agencies. A number of scalable innovations have been piloted successfully by Ndejje University, awaiting implementation, replication and upscaling. Upscaling calls for partnerships and collaborations between diverse sectors and agencies.

Promoting Resilience for Urban Vulnerabilities; prospects for youths-led enterprises

The salient features of the urban landscape in Uganda include: Poor waste management (creating heath complications); dumping of solid waste in water drainage channels (leading to floods); pollution of water bodies by wastewater and solid-waste; deforestation (caused by intense use of firewood and charcoal for cooking and heating) and; use of non-organic fertilizers and pesticides in urban farming (which distort the eco-system). The vulnerabilities are escalated by resource constraints faced by the urban authorities. The commercial-scale briquettes production model at St Kizito High school demonstrates how youths could be incentivized to supplement the resources of the urban authorities in addressing the vulnerabilities. The model demonstrates how youths-led enterprises could

enhance the FABLE nexus by way of; i) converting piles of municipal bio-waste into briquettes to save forests and to reduce flooding; ii) using briquettes-ash as a fertilizer and pesticide for urban farming; and iii) reducing water pollution by recycling bio-waste and wastewater. One of the factors limiting upscaling and replication of the model nationwide is inadequate start-up and scale-up finances. The youths-led enterprises could be optimized through synergies and multidisciplinary integration. Economists, social scientists and natural scientists are well positioned to converge their expertise to develop sustainable models for promoting the urban FABLE Nexus. For instance, briquettes industry is constrained by cheap charcoal and firewood; underpriced by a margin of 30-40%. Accurate valuation of trees by economists, social and natural scientists could facilitate evidence-based policy making to be done by government agencies. While academia develops business and technical models for waste recycling, civil society could do the grassroots implementation. The feasibility of dried fecal sludge as a source of biogas and industrial solid fuel was verified by natural scientists 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. 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). To make this a reality, social scientists need to reduce psycho-social sensitivities associated with using fuel made out of feacal material.

Financial empowerment of the youths: The Social Network Perspective: Given that financial requirements to initiate recycling scheme are high (Walekhwa 2009), capacity building programs should focus on; a) identifying types of resources within youths' communities; b) positioning youths to influence resource exchange within their social networks. Formation of strong social networks anchored on SACCOS is one of the options. Social networks are relationships that exist between individuals/groups; the ties holding them together and resources at their disposal (Borgatti et al 2009). The principle of social network resource-sharing holds that individuals and groups are influenced by ties or connections. The resources include ideas, information, social support and financial support (Scott 2012). The social capital that can be leveraged entails communal use of resources, collective energy, moral support, interpersonal trust and reciprocity (Kadushin 2012). Social networks could act as change agents for youths to acquire and sustain ideal resources and appropriate practices. The network structures could confer benefits, opportunities and/or constraints for the youths (Borgatti et al 2009). Social networks are instrumental in developing efficacy and community resilience for coping with urban sanitation and environmental challenges (Rowson et al., 2010). Building effective social networks could promote self-efficacy among the youths. Waste collectors experience disrespect and outright scorn from fellow-citizens because handling untreated waste is considered demeaning. By earning their own income through recycling, the marginalized youths could develop self-confidence and financial autonomy. For girls in particular, social norming could address stigma created by years of social marginalization. Beyond entrepreneurship and social welfare, environmental issues are central in building resilience against urban vulnerabilities.

Social norming and youths' empowerment: Bio-waste recycling could be influenced by cultural, social and psycho-social factors such as individual, intrinsic motivations, social influences (Kakembo 2018; 2012). New social norms are needed to promote waste recycling (Tucker & Speirs, 2003). Social norming is a psycho-social approach

that cultivates constructive social norms based on social cohesion, peer influence, group consensus; communal decision-making, social pressure and social capital. It ought to address irresponsible waste dumping, zero littering and waste sorting (Nye & Burgess, 2008) and waste recycling. Since young people behave and act in socially acceptable ways, modifying their actions can be achieved through influencing their social networks. As long as an individual depends on the network for wellbeing, he/she is expected to adopt group norms and practices. By promoting social identity and collective value systems, environmental sustainability is incorporated as a guiding principle (Rabinovich et al., 2010). Conceptually, the youths in a social network could 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). The SCOT model stipulates that reasons for acceptance, modification or rejection of a technology lie in the social set-up of the community. Within the notion of interpretive flexibility (Doherty et al 2006), technology generate diverse and evolving expectations among various social groups. For instance, sanitation and energy accessibility make more appeal to females than to males. Overcoming social and psycho-social sensitivities calls for intensive marketing; without which recycling schemes could fail (Robinson & Read, 2005). Because of sensitization efforts, waste recycling and reuse is gradually improving in Kampala city where sludge and urine are used in growing ornamental plants (GTZ, 2010).

Conclusion

The WWE discussed above demonstrate that youths could be incentivized to engage in municipal waste management. Their engagement fills the demand and supply gaps created by the inadequate resources at the disposal of the urban authorities to manage municipal waste. Engaging youths in WWE calls for; 1) capacity building in terms of training and financial facilitation. Government, CSOs academia and other development agencies could play a central role in building the capacity of private waste collectors and the grassroots urban communities. Engaging key stakeholders starts by defining their core interests and thereafter defining the role that they could play. The success of recycling schemes depends on integration of technological, social, and economic approaches. This new pathways for municipal waste management is based on entrepreneurship and business modelling. The approach which departs from the conventional waste collection and disposal models is an innovative approach within the framework of Social Construction of Technology (SCOT). It transcends technology, equipment and infrastructure and embraces social, economic and governance dimensions for promoting municipal sanitation, environment; energy and food security. Waste recycling as a waste management approach makes rational sense even in the absence of social-benefit accounting.

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