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SEVEN BUSINESSES USING PRINCIPLES OF CIRCULAR ECONOMY IN SUB-SAHARAN AFRICA: RESULTS OF FIELD RESEARCH IN UGANDA*

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Abstract

Sub-Saharan Africa is facing multiple challenges regarding waste management, economic productivity, and climate change, all of which seriously endanger sustainable development. The concept of circular economy provides potential solutions for addressing this complex, multidimensional challenge. The aim of this paper is to contribute to the academic research and understanding of the circular economy's status, its application, and its limits in the Sub-Saharan African context. Therefore, the study presents seven Ugandan businesses and entrepreneurs which apply circular economy practices in their operations based on field research conducted in May 2021. The examples touch on plastic recycling, agriculture, carpentry, textile, and paper and packaging industries. The main economic benefits generated are lower input costs, saved waste management costs, and better products for consumers. The improvement of waste collection as well as the reduction of waste landfills and GHG emissions can be considered the most significant environmental benefits. Beside job and additional income creation, better hygienic conditions and improved food nutrient content represent important social benefits. The primary challenges are formed by machinery and production problems which, along with fierce competition over imported products, limit the achievement of economies of scale to support economic sustainability of these initiatives.

Keywords

circular economy, sustainable development, Sub-Saharan Africa, Uganda

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Introduction

According to the World Population Prospects of the United Nations Population Division (2019), the population of Sub-Saharan Africa is projected to increase 2.5 times by 2050. The World Bank's *What a Waste 2.0* report (Kazat et al., 2018) expects the amount of municipal solid waste to nearly triple in Sub-Saharan Africa by 2050. In 2016, 44% of the waste was collected in the region, while Europe, Central Asia, and North America collected at least 90% of their waste. According to the World Bank's World Development Indicators (2022), rapid industrialization in Sub-Saharan Africa has led to industry output (including construction) being five times higher in 2019 compared to 2001, and total consumption expenditure being four and a half times higher in 2018 compared to 2001.

Consequently, African countries are among the most endangered by climate change globally. The Climate Change Vulnerability Index 2017 (Reliefweb, 2022) evaluates the vulnerability of human populations to extreme climate events and examines potential changes in climate over the next 30 years. It combines exposure to climate extremes and changes with the current human sensitivity to those climate stressors and the capacity of the country to adapt to the impact of climate change. As visible on the map below, the decisive majority of high and extreme risk areas (orange and red) are in Sub-Saharan Africa.

Population growth and urbanization processes are increasing the fastest in this region and typical consumption patterns are changing and moving toward more packaged products and electronics. Thus, a comprehensive rethinking and reconceptualization of waste management and utilization, product life cycles, and prevailing business models are needed to prevent serious environmental damage and deterioration of living conditions. Furthermore, the *What a Waste 2.0* report (Kazat et al., 2018) highlights serious gaps in availability of data and studies on waste management and utilization processes in Sub-Saharan Africa, and it also provides research on green transition, sustainable development, and opportunities to mitigate climate change more and more relevant and urgent.

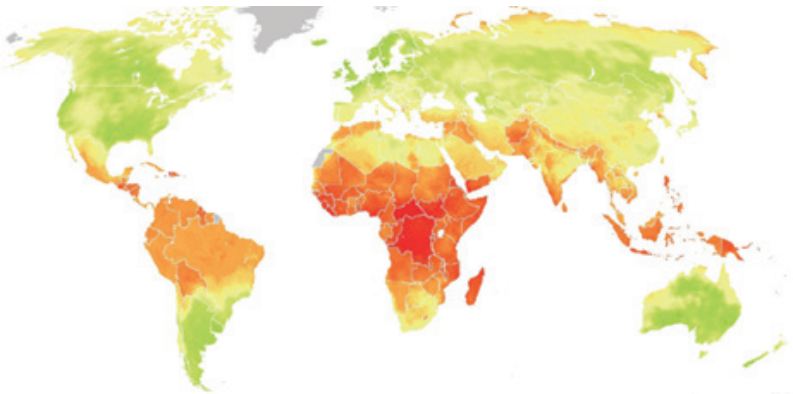

Figure 1. Climate change vulnerabilities, Source: Reliefweb, 2022

For tackling this combined challenge, the concept of circular economy promises potential solutions. The aim of this paper is to contribute to the academic research and understanding of the circular economy's status, its potential application, and its limits in the Sub-Saharan African context. Thus, the study is structured as follows. First, the causes of and challenges related to an absent economic productivity increase in Sub-Saharan Africa are introduced. The concepts and main models of circular economy are briefly summarized. This is followed by the central part of the paper including the results of field research implemented in May 2021. Seven Ugandan businesses and entrepreneurs applying circular economy practices in their operations are presented with a specific consideration of the economic, environmental, and social benefits as well as the main challenges of their activities. Finally, findings are discussed.

A Crucial Challenge for Sub-Saharan Africa: Missing Productivity Increase

McMillan et al. (2017) point out that Sub-Saharan Africa experienced an unusual phenomenon of structural change between 1990 and 2010. This meant that employees migrated from the traditionally low-productivity agricultural sector to the lower productivity service sector, but not to the higher-productivity manufacturing and industrial sector. Since productivity is the foundation for economic growth, this stagnating—sometimes even decreasing level of productivity—is seriously curbing the chances of African countries to achieve convergence with developed economies. For example, in Nigeria, productivity growth in manufacturing between 1996 and 2009 was negative relative to agriculture. In Ghana between 1992 and 2010, manufacturing's total contribution to productivity increase was zero. In Zambia, labour productivity grew by only 0.31% between 1991 and 2010, and today still half of the population is employed in low-productivity agriculture.

But why are the opportunities for growth based on manufacturing or other industrial activity limited to African countries? Perhaps the simplest answer is that many African countries have significant amounts of natural resources. These are much easier to extract and sell, and the specialization required to produce them would require a lot of time, financial effort, and human resource development. Furthermore, the success of East Asian economies poses significant challenges to new competitors in the manufacturing industry, especially in light of the fact that globalization has greatly reduced barriers to international trade. To a greater extent than before, new trade rules such as local content requirements, subsidies, and import restrictions limit room for manoeuvring and opportunities for industrial policies successfully pursued by Asian countries. However, the economic difficulties of developed countries (due to the financial crisis of 2007-2009 or the recession caused by the current coronavirus epidemic) mean less demand for exports from developing countries. Furthermore, technological changes in manufacturing have made the sector much more capital- and knowledge-intensive than in previous decades, thus reducing the benefits of poor economies in manufacturing and the potential for labour absorption in the sector. The prospects for climate change and the risks associated with it have created greater

awareness and demand for environmentally friendly solutions, but this also requires the introduction of more expensive green technologies for developing countries if they are to participate and survive in global trade.(McMillan et al., 2017).

As long as the above-mentioned tendencies of population and consumption growth are not coupled with productivity growth, the economic, social, and environmental situation will unlikely improve. Therefore, a solution is needed that ensures the increase of productivity levels by filling the gap of the missing manufacturing sector or productivity in the service sector, and curbs environmental degradation via resource efficiency.

To contribute to this search for solutions, the following part of the paper shortly introduces the concept of circular economy and its main models.

The Concept of the Circular Economy: Design and Business Model Strategies for Circularity

The circular economy originates in the works of Ready and Stahel (1977), and the concept has gained attention among academia and policymakers over the last two decades as a powerful theoretical framework for sustainable development (Geissdorfer et al., 2017). The circular economy views nature as an example where there is no waste and each output is an input for another process. Thus, the circular approach contrasts with the *take-make-use-dispose* logic of the conventional *linear economy* (Bakker et al., 2014) and argues for a nature-like circularity in the economic system. This means that the value of products, materials, and resources are maintained in the economy as long as possible, resulting in a minimized amount of waste and a sustainable management of resources. Based on Bocken et al. (2016), the circular economy can be described as a set of design and business model strategies that are slowing (i.e. reusing), closing (i.e. recycling), and narrowing (i.e. using less materials for production) resource loops. Regarding design for slowing loops, two basic strategies are the most well-known: *design for long-life products* and *design for product-life extension*. Three strategies focus on closing the loops: *design for* a *technological cycle*, a *biological cycle,* and *disassembly* and *reassembly.*

There are several business model strategies for slowing the loops. The essence of the *access and performance model* is about satisfying users' needs without owning physical products. The best examples are car sharing, launderettes, document management systems, and leasing jeans, other clothes, and phones. The *extending product value model* is characterized by the free-of-charge retaking and remanufacturing of products by the manufacturer, as is seen with refrigerators or in the automotive industry when car parts are remanufactured. Another example mentioned by Bocken et al. (2016) is the company Gazelle, which offers customers cash for used electronics and refurbished electronics. H&M's clothing return initiatives can also be included. Similarly, the classic *long-life model* consists of the product with a durable design and a guaranteed repair service, such as luxury products claiming to last a lifetime (Rolex watches). An extreme form is the *encourage sufficiency model* where producers or resellers build their brands on telling the costumer not to buy

Business model	Description
Access and performance	Satisfying users' needs without owning physical products
Extended product value	Free-of-charge retaking and remanufacturing of the products by the manufacturer
Long-life	Durable design and a guaranteed repair service
Encourage sufficiency	Producers or resellers build their brands on telling the costumer not to buy certain products
Extending resource value	Collecting or sourcing waste materials and resources to turn these items into new forms of value by finding another useful function
Industrial symbiosis	End-products, by-products, or waste-products of one industrial activity can be an important input of another one

Table 1. Circular economy business models, Source: Bocken et al. (2016)

certain products, which is a model used by companies such as Vitsoe and Patagonia as well as energy service companies.

Among business model strategies that focus on closing loops, the *extending resource value* model is about collecting or sourcing waste materials and resources to turn these into new forms of value by finding another useful function. For example, the company Interface, collects and supplies fishing nets as raw materials for carpets. Finally, *industrial symbiosis* refers to how certain end-products, by-products, or waste-products of one industrial activity can become important input for another production activity.

To categorize circular economy business models and strategies, Rood and Kishna (2019) introduced the *R-ladder* comprised of six circularity strategies: R1 – Refuse and Rethink, R2 – Reduce, R3 – Reuse, R4 – Repair and Refurbish, R5 – Recycle, and R6 – Recover. The numeric order of the ladder also represents the order of priority based on the energy used in the process. Thus, while *refusing* does not involve any energy, at the other end of the scale *recovering* means to regain energy from the material (most frequently by burning it).

Examples of Businesses Utilizing the Circular Economy in Uganda: Results of Field Research

This part of the paper shortly introduces seven examples from Uganda, including businesses and entrepreneurs applying circular economy models. The sites were visited and interviewed during field research in Uganda in May 2021. These locations were selected from Footprint Africa's Circular Economy Case study report (2021) and based on the recommendation of experts at the Uganda Cleaner Production Center and the National Planning Authority. The examples include plastic recycling, agriculture, carpentry, textile, and paper and packaging industries. Beside introducing core activities, the research focuses on highlighting the economic, environmental, and social benefits created by these businesses, while competitor products and main challenges are also discussed.

Hya Bioplastics is a young organization, started as a pilot project of students at the Makerere University in Kampala in 2018. The organization focuses on the replacement of plastic with research and development on the productive utilization of water hyacinth, an invasive plant growing in Lake Victoria and other freshwater systems, which is causing serious problems for the fishery industry. Water hyacinth is usually harvested by fishermen to clear up fishing areas and dumped as waste or used as animal feed. Hya Bioplastics© pilot products are trays, packaging tools, coasters, and name tags from "biodegradable plastic" based on the mixture of dried water hyacinth, sawdust, and casava starch. The customized products are sold mostly to restaurants and bars. As the plastic replacement business is still in the initial phase, Hya Bioplastics also started to produce sawdust-based briquettes sold to poultry farms or households to replace charcoal that is more polluting and less efficient. Briquette selling provides the company with additional revenue to invest in further research and development on the production of alternatives to plastic. Sawdust is supplied free of charge by a carpenter company called Motiv Creations. Prior to this agreement, the disposal of this by-product was costly and problematic.

Economic benefits of Hya Biplastics include the following: cheaper production of its products based on low-cost or even free input prices, the additional revenues due to easier fish production, improved production efficiency of poultry farmers with more durable and more efficient sawdust briquettes, and lower landfill costs with Motiv Creations. There are also clear environmental benefits: reduced or avoided landfill of sawdust, less pollution from poultry farming, reduced usage of plastic, and increased maintenance of natural fishing areas and promotion of biodiversity. Lastly, the social benefits include the contribution to additional revenues and the creation or conservation of jobs for casava farmers and fishers.

Despite these benefits, there are some challenges. On the one hand, the lack of water resistance in packaging products require large investments in technological research and development. On the other hand, cheap imported plastic products pose serious competition. The combination of these two factors limits the increase of market share and economical production.

Picture 1. Hya Bioplastics trays as an alternatives to plastic, Source: www.hyabioplastics.com, 2022

Amelia Agro Ltd. is an organic farm on eight acres in Jinja, 100 kms East of Kampala, the capital. The farm grows several varieties of plants and raises animals (chicken, fish, pigs, cows, goats, and rabbits). The organization is an excellent example for making use of other companies' waste or by-products as compost, animal feed, or organic pesticide. Bagasse (the left-over of crushing sugar cane) is received from sugar companies. Slaughterhouses supply them with blood, intestines, and flesh off-cuts, as other flesh remaining is also supplied by fishers, fish processers, and tannery companies. From paper companies, the carbon-rich boiler ash is a valuable source for keeping the soil fertile, while floating barley and husk from breweries are being fed by the pigs and used as compost. Water hyacinth comes from the Jinja Sailing Club and is used as pig and chicken feed. Finally, effluent from spirit producers is also used for composting. The farm's products are sold on the local market and to restaurants. Another supply of organic waste comes from restaurants in the form of fruit and vegetable peels and food left-overs. Beside the in-coming organic waste supply, within the farm there is a circular model of materials. Everything is utilized for feeding or composting, such as animal manure, garden weed, or other plant residue.

Economic benefits: The competitive advantage of this farm is to make and keep the soil fertile with high nutrient content and also profit from increased crop and animal production. The big advantage of the industrial symbiosis practices is that most of these supplies of nutrient rich ingredients are received free of charge, and the only cost for the farm is transportation. Additionally, supplier companies can realize serious reductions of costs associated with landfills. Among the several environmental benefits created by the farm, one important benefit is the avoidance of waste in landfills, which results in the reduction of open-air waste decomposition and green-house gas emission. Moreover, the improved soil quality can contribute to the increase of carbon sequestration capacity, which is a crucial factor in the mitigation of climate change. Social benefits: The farm tries to avoid the use of machinery as much as possible. Therefore, it employs a relatively high ratio of human workforce and creates jobs. Organic agriculture may contribute to better nutrition conditions.

Picture 2. Boiler ash in windrow compost at Amelia Agro farm, 12th May 2021, author's photo

As main challenges, the following elements have been identified. In spite of these above advantages, Amelia Agro still struggles to reach profitability, as organic agriculture is very labour-intensive, soil nutrient improvement is time-consuming, and low local demand and purchasing power for organic crops (compared to non-organic ones) does not allow significant price differentiation. Furthermore, the farm faces serious competition with imported chemical fertilizers and industrial animal feed.

ProTeen utilizes black soldier flies to process organic waste in fertilizer and animal feed. The organization has a strategic partnership with the Kampala Capital City Authority (KCCA) waste management department, which supplies organic waste from different markets in the city. The waste of these markets is estimated to be 80-90% organic. Additional organic waste is also delivered by private waste collectors and food processing companies. The organic materials are shredded and mixed, and the black soldier fly larvae eat it up within eight days. The larvae function as the input material for three different products: a protein-rich animal feed that is primarily purchased by large chicken producers, fat-rich extracted oil that is a useful input to pig and other animal feed, and a fertilizer granulate used by organic farmers (typically coffee farmers) to return nutrients to their farms. As industrial fertilizers usually imported from the Netherlands are expensive, only a few organic fertilizers are available locally. Proteen's technology is much faster than composting and their technique has a competitive advantage while contributing to waste processing with reduced greenhouse gases emissions. Moreover, other alternatives from competitors such as silver fish-based fertilizers are more expensive with lower and unreliable quality due to limitations in production.

Picture 3. Black soldier flies at Proteen's site in Kampala, 25th May 2021, author's photo

One of the key economic benefits is that supplier companies and municipalities can save on landfill and waste management costs. Farmers and animal keepers can obtain cheaper and better-quality organic fertilizers and animal feed, and they are able to produce locally. Environmental benefits are that the organization's activities also contribute to the reduction and avoidance of waste landfills, as well as the reduction of open-air waste decomposition and green-house gas emission. By returning organic nutrients to nature, the soil quality and carbon sequestration capacity is also strengthened. Social benefits: ProTeen creates new jobs and improves food nutrient content that indirectly contributes to better social nutrition and health conditions. The biggest challenge for Proteen, as is the case for most of the companies discussed, is to provide machinery to achieve economy of scale and ensure production with consistent price and quality.

TexFad is a non-profit organization that deals with hand-woven textile products in the suburbs of Kampala. The production of carpets, table mats, scarfs, and other handcrafts are based on two inputs: textile off-cuts and banana stem. Textile off-cuts and reject cotton thread (a product of errors in production or defective products that are three time cheaper than normal ones) are supplied by two cotton factories: Nytil in Jina and Fine Spinners in Kampala. Banana tree stems come from local farmers (four large-scale plantations and ten small-scale producers) and the fibre is extracted at TexFad. After a banana tree has produced its fruits and completed the harvest, it does not grow any more fruit. The 3-5 meter tree remains as waste with an unused potential. The extracted fibre is used for carpet-weaving, and the remaining parts are used for the production of organic fertilizer and carbonized briquettes (like in the

Picture 4. Hand-woven carpet from banana fibre and textile off-cuts under preparation at TexFad in Kampala, 19th May 2021, author's photo

example of Hya Bioplastics). TexFad is investing in further research on the treatment of banana fibre so that it can replace cotton in the future. Carpets and table mats are typically sold to hotels and apartments, while briquettes and fertilizer are sold to poultry farmers, restaurants, homes and schools.

The company takes advantage of lower input costs and contributes to additional revenue generation of textile producers and banana farmers, as an economic benefit. Households as well as catering and poultry businesses benefit from the more durable and efficient briquettes as solid energy sources. Additionally, suppliers can save on landfill costs. Environmental benefits: TexFad also contributes to the avoidance of landfills, the reduction of green-house gas emission based on open-air waste decomposition and air pollution by using briquettes instead of charcoal for cooking, and improvement in soil quality and carbon sequestration capacity. Social benefits: The organization creates additional jobs and revenues. Nevertheless, competition with imported plastic rugs and carpets, chemical fertilizers, and charcoal producers pose the main challenges for TexFad.

TakaTaka Plastics is based in Gulu in Northern Uganda, and the company deals with plastic recycling. In the local language, Acholi, *Taka* means *waste*. Thus, the name choice represents a mission to change the local perspective about waste along with how it is utilized and valued. The organization was founded in 2020 by recent university graduates who won six different business competitions to obtain funding for launching the project. TakaTaka Plastics processes disposed plastic bottles and bags to produce a large variety of products, such as roofing and wall tiles (their main product), construction lambers, clips, strings (used in basket weaving), face shields, and glass coasters. Plastic is collected in the city of Gulu and the surrounding area in several ways. The company has deployed plastic collection banks in nine schools as well as several restaurants, bars, and other public places. Hospitals supply around 70 kg of plastic per week. Together with local authorities TakaTaka organizes monthly community waste collection actions that supply an average of 200 kgs of plastic

Picture 5. Wall tiles representing 650 recycled soda and water plastic bottles at TakaTaka Plastics office in Gulu, 21st May 2021, author's photo

to process. 90% of the plastic is collected for free, which provides the basis for a great competitive advantage against ceramic tiles, the main product competing in the market. Beside being cheaper, TakaTaka Plastics tiles are also more durable and recyclable compared the conventional ceramic options. The company plans to have a self-sustaining operation within the next two years in Gulu, and open additional processing stations in other cities such as Arua and Hoima. To increase collection and production efficiency and to reduce the operation's carbon footprint, they envision that the equipment in the local collection points will include shredders to enable preprocessing of the plastic to improve the amount-per-transport ratio. The company also plans an extension of the recycling portfolio to include aluminium cans as well.

TakaTaka's benefits a lot from input material being very inexpensive because the input costs only include transportation. Consumers can buy cheaper and more durable tiles, while municipalities can save waste collection and management costs. Environmental benefits: The beneficiaries of the company's activities are local communities and nature, as plastic waste is collected and public areas are kept cleaner (environmental benefit). From the social benefits' point of you, beside job and additional income creation, TakaTaka contributes to social awareness-raising, better hygiene, and improved health conditions.

Despite these advantages, the business is still not economically developed because it still struggles to reach economy of scale. At the time of the interview, TakaTaka processed one ton of plastic per month and, according to their calculation, economic sustainability would be reached at the level of nine tons for monthly production. This is also reflected in their income structure: only 20% comes from the actual business, while 40% comes from different business grants and another 40% from donations. Beside finding funding, the most challenging factor is to provide cheap and reliable machinery, as it is very expensive to import and locally manufacture the machines required for the company's operations.

Ecobrixs, a company in the city of Masaka, processes plastic bottles. Their main products are plastic bricks, support columns, used in construction. They also produce face shields, baseball cap inserts, book covers, and black boards with frames from recycled plastic. These latter products are mostly purchased by local NGOs, schools, and hospitals. An important feature of Ecobrixs' model is the incentive system for waste collection in which the company pays for the collected plastic. This ensures a stable production input supply, as individuals can gain additional income by delivering plastic to Ecobrixs' 30 collection centers within a 100 kms radius of Masaka. Apart from the collection centers, the company also receives plastic waste from 28 schools. The organization only has to provide the transportation from the collection centers, which is carried-out by drivers and their collection trucks.

Inputs are inexpensive for Ecobrixs. As their construction products are cheaper than concrete and more durable than timber – the two competitors' products – the company's market share is markedly increasing. Municipal waste management costs are also reduced. Environmental benefits: Similarly to TakaTaka, the company con-

Picture 6. Brick, black board and frame from plastic at Ecobrixs in Masaka, 17th May 2021, author's photo

tributes to the collection of plastic waste and therefore helps to keep natural and public areas cleaner. Econbrixs directly provides full-time jobs for 13 employees in their process station in Masaka and 25 jobs in the collection centers, while an average of 165 individual plastic collectors can gain additional income while cooperating with the organization. Moreover, cleaner public areas and nature contribute to improved hygiene and health conditions.

Mostly challenging for Ecobrixs that machinery deficiencies and production capacity still hinder profitability.

The *Uganda Industrial Research Center* (UIRI) experiments with several technologies related to cleaner production and the utilization of waste materials, such as replacing timber with bamboo and the utilizing cotton husks for mushroom growing and glass waste in ceramic production. During the research and site visit, one of the most impressive and advanced initiatives was led by Samuel Nuwagaba who works on using paper and agricultural waste such as banana fibre or other plants like sisal to produce alternative paper and packaging products. As discussed previously, banana fibre is available in huge quantities in Uganda and in broader Sub-Saharan Africa. The packaging industry is still dominated by plastic products, mostly imported from China, India, and Kenya. Nuwagaba invented a mixture of banana fibre and waste paper (30-70 percent ratio, respectively) which provides offices with alternative recycled paper. He also produces other paper products from banana fibre exclusively, such as bags, notebooks, and boxes. These are purchased by local art centers, shop owners, and tour and travel operators to make their products and services more attractive to tourists. The products are also purchased by foreign NGOs primarily from The Netherlands, Germany, and Japan.

Input materials are free and local craft sellers and tour operators can increase their value proposition. The initiative contributes to the reduction of plastic usage and paper production. As the project is in an initial phase, the social and environmental benefits are difficult to identify. In the long term, shifting paper production

Picture 7. Paper sheets from banana fibre at UIRI in Kampala, 6th May 2021, author's photo

to banana and other alternative input materials may create new jobs and economic sectors in Uganda and the broader Sub-Saharan Africa. However, machinery deficiencies (regular break-down and malfunctioning) and limited local manufacturing and repair expertise pose serious obstacles to reliable and profitable production.

Discussion and Conclusions

These above examples of businesses in Uganda demonstrate a wide range of activities where circular economy business models and practices have already become established in Sub-Saharan Africa. After learning about some of the economic and socio-cultural tendencies on the continent, these businesses demonstrate promising entrepreneurial and environmental initiatives and optimism about the future.

To reflect on the contribution of each project to sustainable development, the resulting economic, environmental, and social benefits should be considered. The most common economic benefits of these above organizations include utilizing cheaper input materials, saving costs for suppliers and municipalities such as those related to landfill and waste management, and providing better products for consumers. Concerning environmental benefits, each presented initiative contributes to the reduction of waste landfills and the improvement of waste collection or utilization. Agricultural initiatives (e.g., Amelia Agro and ProTeen) or partly-agricultural ventures (e.g., TexFad) also contribute to the reduction of greenhouse gas emissions and help mitigate global warming and climate change. Projects focusing on plastic waste as a production input significantly improve the survival chances of natural habitats and keeping municipal areas cleaner. Beside job and additional income creation, better hygienic conditions and improved nutrient content in food represent important social benefits.

However, implementation of the circular economy in Uganda and across Africa must still be improved because there are serious challenges these business initiatives face. Six of the seven businesses examined in the field research reported that they struggle with reaching the break-even point to make their ventures economically sustainable. These are excellent initiatives, but they should be considered pilot projects

that address sustainable development in Africa. They are all extremely dependent on donations, tourism, and other funding support such as grants. They also struggle to become economies of scale mostly due to the missing availability of proper technology and machinery. Cheap or even free-of-charge input prices hardly counterbalance the fierce competition with imported goods. A possible form of further support would be subsidies or other economic incentives from the state. However, at the time of this publication, these forms of support have not occurred in Uganda.

Note

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Appendix 1 – Summary of Economic, Environmental, and Social Benefits and Challenges

Company	Economic benefit	Environmental benefit	Social benefit	Challenges
Hya Bioplastics	Free input (sawdust) – cheaper production Easier fish production More durable and efficient briquettes for poultry farmers Saving landfilling costs	Avoidance of sawdust landfilling Less pollution during poultry farming Less usage of plastic Conservation and maintenance of natural fishing areas	Additional revenues and job opportunities for casava farmers and fishers	Competition with plastic products and charcoal producers Development of water resistance of products Economies of scale
Amelia Agro	Lower input costs Higher fertility of soil and higher production rates Saving landfill costs of suppliers	Avoidance of waste landfilling Reduction of open-air waste decomposition and GHG emission Improvement of soil quality and carbon sequestration capacity	Job-intensive production – job creation Improvement of food nutrient content	Economies of scale Competition with non-organically grown agricultural products, imported chemical fertilizers, and industrial animal feed
ProTeen	Lower input costs Saving waste management costs for the municipality and supplier companies Reliable quality for buyers – production increase Cheaper organic fertilizers Faster production of organic fertilizers	Avoidance of waste landfills Reduction of open-air waste decomposition and GHG emission Improvement of soil quality and carbon sequestration capacity	Job creation Improvement of food nutrient content	Machinery to achieve industrial and daily constant production with constant price and quality Competition with industrial animal feed and fertilizers with other organic fertilizers

TexFad	Lower input costs Additional revenues for textile producers and banana farmers More durable and efficient solid energy sources (briquettes) for households and businesses Saving on landfill costs	Avoidance of waste landfills Reduction of open-air waste decomposition and GHG emission Improvement of soil quality and carbon sequestration capacity Reduced air pollution by heating and cooking	Job creation	Competition with imported plastic rugs, carpets, chemical fertilizers, and charcoal producers
TakaTaka Plastics	Lower input costs Cheaper and more durable products for consumers Reduction of municipal waste management costs	Waste collection Reduction of plastic waste in municipal and natural areas Cleaner natural and municipal areas	Job-creation Additional income for plastic collectors Awareness-raising Better hygienic conditions	Machinery and market share to achieve economies of scale Competition with ceramic tile producers
Ecobrixs	Lower input costs Cheaper and more durable products for consumers Reduction of municipal waste management costs	Waste collection Reduction of plastic waste in municipal and natural areas Cleaner natural and municipal areas	Job-creation Additional income for plastic collectors Better hygienic conditions	Machinery and market share to achieve economies of scale Competition with concrete products (more durable) and timber products (cheaper)
Samuel Nuwagaba (UIRI)	Lower input costs Additional value proposition opportunities for local art and craft sellers and tour operators	Reduction of the usage of plastic Reduction of paper production	N.A.	Machinery and local technical expertise for reliable production – limited market share Economies of scale