Supporting Enterprises in Capturing Waste Value

Lessons Learned from the CapVal Sanitation Project in Ghana

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THE PROJECT

The CapVal project proposes three resource recovery and reuse solutions (nutrient, energy and water reuse) that have a high potential to incentivize local sanitation planning and management in Ghana, reduce waste transport costs, support the lifetime of landfills and reduce environmental impacts through the establishment of co-composting, briquette and wastewater-fed aquaculture businesses in two regions of Ghana. All three interventions have been supported by capacity development of the private and public sectors. The principal CapVal project implementation team comprises:

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ACRONYMS AND ABBREVIATIONS

BoD	Board of Directors
CapVal	Creating and Capturing Value: Supporting enterprises for urban liquid and solid wastes recycling for food, energy and clean environment
CSO	Civil Society Organization
FS	Fecal Sludge
FSTP	Fecal Sludge Treatment Plant
IRR	Internal Rate of Return
IWMI	International Water Management Institute
JVL	Jekora Venture Limited
KMA	Kumasi Municipal Assembly
MoFA	Ministry of Food and Agriculture
O&M	Operation and Maintenance
PFJ	Planting for Food and Jobs
PPP	Public–Private Partnership
TMA	Tema Municipal Assembly
TREND	Training Research and Networking for Development
VGICL	Volta Ghana Investment Company Limited
WaFo	Waste to Food project
WWTP	Wastewater Treatment Plant
YKMA	Yilo Krobo Municipal Assembly

EXECUTIVE SUMMARY

This document, which is based on an IWMI-commissioned review prepared by a third party, presents outcomes and lessons from the CapVal project implemented in Ghana from 2015 to 2021. CapVal or 'Creating and Capturing Value: Supporting enterprises for urban liquid and solid wastes recycling for food, energy and clean environment' was initiated by the International Water Management Institute (IWMI) with funding of EUR 1.2 million from the Netherlands Ministry of Foreign Affairs and matching contributions from IWMI (at least EUR 390,000), Training Research and Networking for Development (TREND) (at least EUR 10,000), the Yilo-Krobo Municipal Assembly (at least EUR 55,000), TriMark Aquaculture Centre (at least EUR 115,000) and Jekora Ventures Ltd (JVL) (at least EUR 200,000).

In Ghana, CapVal aimed to support the commercialization of three liquid and solid waste derived by-products: (i) compost from the combined treatment of dry fecal sludge and municipal solid waste; (ii) fuel briquettes from organic waste; and (iii) fish cultured in treated wastewater. Potential financial gains from by-product commercialization provide a strong rationale for the initiative as they could contribute to funding and enhancing of sanitation services. The project also had the potential to generate socioeconomic benefits, including job creation, market adoption of organic fertilizer and fish, and direct environmental benefits of sound waste management.

Private sector participation was considered, from the outset, to be key to project design and implementation. Global research conducted by IWMI prior to CapVal indicated that private sector-led waste resource recovery businesses could generate substantial financial returns. IWMI had also successfully supported the signing of the Joint Venture (JV) agreement between Tema Metropolitan Assembly and JVL (a local company specialized in waste management services) for the operation of a co-composting facility in 2013.

The project initiated innovative partnerships between public and private actors as well as civil society organizations (CSOs). IWMI partnered with TREND, a local organization, to facilitate stakeholder engagement for knowledge sharing, capacity development and policy/regulation compliance. Private partners identified at the project conception phase were JVL, Volta Ghana Investment Company Limited. (a local developer), Presank Enterprise Limited (a local waste management enterprise) and TriMark (a local enterprise specialist in aquaculture). Public sector actors were Kumasi Metropolitan Assembly (KMA), Shai Osudoku District Assembly (Afienya) and Techiman Municipal Assembly, which would benefit from production facilities being established in their jurisdictions.

What Has CapVal Helped to Achieve?

Infrastructure for Waste Treatment and Valorization

CapVal constructed three production facilities at two sites that were operational by 2021. The first site is in Akorley near Somanya, the administrative capital of Yilo Krobo Municipal Assembly (YKMA) and the second site is in the jurisdiction of the KMA.

Akorley (Somanya) hosts both the composting and briquette facilities. The composting facility has a theoretical production capacity of 200 tonnes annually. Depending on waste characteristics, it can transform up to 5,000 cubic meters (m^3) of fecal sludge and 300 tonnes of organic solid waste per year. Fecal waste is sourced from private and public onsite sanitation systems (pit latrines and septic tanks) in nearby communities and organic waste from local markets (mainly fruit and vegetables), poultry farms and sawmills. The Fecal Sludge Treatment Plant (FSTP) constructed under CapVal is the first of its kind in YKMA, a municipality with 100,000 residents.

The briquette business has a theoretical production capacity of 1,000 tonnes per year. Briquettes are produced using sawdust and wood shavings (there are plans to add rice husks), and the waste fractions are collected from neighboring areas. The briquette facility is only the second of its kind operating in Ghana as of 2021. Establishment of the facility benefited from lessons learned from a business operating in Kenya (Kings Biofuels Ltd.) which uses similar raw materials and machines and supplies fuel mainly for industrial use.

The aquaculture business operates from the grounds of a Wastewater Treatment Plant (WWTP) in Kumasi. The Chirapatre WWTP is one of the five small-scale WWTPs owned and operated by the KMA. It receives about 30 m^3/day from 1,800 domestic customers. The business delivers three main products derived from African catfish (*Clarias gariepinus).* It produces broodstock for breeding, fingerlings for farmers and fish cultured in groundwater for consumption. Through CapVal, the Chirapatre WWTP was enhanced to include three biogas digesters to improve treatment before discharge into the five ponds in series, including the last two treatment ponds where the broodstock is produced. This component uses the nutrient-rich wastewater to produce breeding fish which in turn produce fingerlings in onsite hatchers. Treated wastewater ponds are only used to grow the broodstock. Some fingerlings produced in the hatchery are transferred to onsite concrete tanks where they are fully grown using fresh underground water.

Public–Private Partnership (PPP) Agreements

Both the Akorley (Somanya) and Kumasi treatment and production sites are operated under JV agreements. YKMA and JVL signed a 20-year JV agreement, while KMA and TriMark are committed to a 15-year agreement. The JVs signed with YKMA and KMA are similar to that signed with the TMA in 2013. At their inception, all three were the first of their kind in Ghana related to waste management and by-product commercialization.

The JV model was selected as it balances the risks faced by both private and public actors. The JV contract extends co-ownership of all assets (including land) to both parties over the agreement timeframe. From a private sector perspective this means that they can only be excluded from using the assets if they fail to meet the operating and production standards specified in the contract. Under the JV model designed in CapVal, potential revenues from the business are to be collected in a special account and equally shared once the business breaks even.

The private sector also brought working capital to cover operating costs in the first few years of business operations. According to the JV agreement, the private sector is in charge of all operations and maintenance (O&M) while public actors are required to supply the land (or enable secured access to the facility) and ensure the regular supply of waste, particularly through enforcement of sanitation and waste regulations. At both sites, the private sector has also carried out some investments. JVL contributed 5% of initial costs (including the acquisition of vehicles for waste collection). In Kumasi, TriMark mobilized over EUR 150,000, mainly through public funds (including international donors) to enhance treatment capacity and diversify production.

Private partners changed over the course of the project. Two who were initially in the proposal to the Dutch Embassy (Volta Ghana Investment Company Limited or VGICL and Presank) pulled out; one due to lack of land and the other because it realized it could not meet the working capital required.

What Are the Lessons Learned for Supporting Waste Valorization Enterprises?

Waste Valorization Can Be Profitable, but at a Small Scale

Catfish and briquette production are showing promising signs of profitability, albeit at a small scale. Demand for catfish (and associated products) is very strong in Kumasi (as in other parts of Ghana) and production and sales volumes were increasing until the COVID-19 crisis that halted production. The market for briquettes is

also promising. As of March 2021, as the facility is only starting production, potential bulk buyers have been identified and there is confidence that demand is strong for factories looking at alternative fuels to charcoal.

The compost business faces the most challenges and risks in terms of financial viability. Risks mainly relate to tough competition from other fertilizer suppliers able to offer higher volumes of products at a lesser price. In Ghana, this is also enabled by the government subsidy policy which disadvantages small-scale fertilizer producers. At the time of writing this report, potential customers were not familiar with the compost business. Boosting revenues requires more efficient design of the facility, by shifting from manual to mechanical processes. Profitability may also require production at a larger scale.

It has to be acknowledged that business models underlying facilities' operations do not take into account depreciation. While all businesses are expected to break even within 3 to 5 years of operations (or before in the case of catfish production), the future costs of assets' replacement and large repairs are not taken into account. The expectation is that these costs will have to be covered by public funds, rather than through business revenues.

Small- and Medium-size Enterprises (SMEs) Are Best Positioned in the Waste Resource Recovery Sector

Some companies and entrepreneurs can be attracted to the sanitation and waste valorization sectors. There is a particular incentive for those already working in solid waste management and fecal sludge emptying as the FSTP also provides a safe treatment and disposal facility. However, there is a need for contracts that balances risks taken by both parties.

In the short term, SMEs are likely to be best placed to take on the risks involved in the waste resource recovery business. Larger companies with higher financial capacities may not be interested in investing in waste management due to limited potential for revenue generation compared with other business sectors. At the same time, private companies that can be involved need to have financial status that enables them to deploy working capital.

Private sector participation in the management of waste treatment plants enhances treatment processes and standards. FSTPs and WWTPs can be turned into grounds for attractive businesses that can enhance treatment processes and plant maintenance. TriMark is clearly on the path of becoming a thriving business, although most investments are still coming from external funders.

Public Funds Are Needed, Especially at Early Stages of Business Development

CapVal was made possible by the allocation of public funds for capital investment and institutional support, including capacity development, business development support and regulation compliance. This initial investment and package of support has been critical for mobilizing additional resources, including those from local governments and the private sector. Revenues generated to date indicate that waste resource recovery businesses will continue to require this initial public support in order to take off.

CapVal also indicates that public funds for supporting waste resource recovery businesses are likely to be required at least during the business incubation stage, which can last up to 3 to 4 years. Indeed, at early stages, businesses are still testing and calibrating production and engaging with potential customers, with little to no revenue generated over a substantial period of time. Both the briquette and composting businesses supported by CapVal could not break even for at least 3 years into operations. Considering the environmental and socioeconomic benefits these businesses can generate, there is a rationale for extending public funding support into these initial years of operations, mainly for assisting with business development and providing research insights.

A key policy take-away is the need to specifically subsidize organic compost and to increase awareness of its benefits among farmers to boost the uptake of this alternative product. As of 2021, the fertilizer subsidy program in Ghana targeted both organic and inorganic fertilizer producers; however, small-scale producers such as JVL were excluded from the subsidy program due to the limited size of their production. The subsidy policy should be revised to enable such small-scale producers to compete with larger producers. Finally, communications that promote the benefits of organic fertilizers should be led by government agencies, rather than being left to producers alone.

Another key role for public actors is to make land available. CapVal experienced delays due to lack of land, which implied changes of partners and locations and impacted on project resources. If Ghana – and other countries – are to tackle the challenge of waste management, land needs to be allocated for this purpose. Allocation of land for waste management must be prioritized in the development of spatial plans by the land use and spatial planning authority. This may require allocating funds to acquire and register it officially before competent authories to protect ownership, and to obtain the required permits.

Civil Society Organizations Have an Important Role to Play to Boost Skills and Knowledge on Waste Valorization and in Building Markets

Research institutes and CSOs have an important role to play for:

- **Developing the knowledge and capacity of private and public actors:** Waste valorization is a relatively new business line for the private sector and the PPP model implemented under the project is innovative for local governments**.** Knowledge transfer on the potential of waste valorization, production techniques and how to engage with the private sector is therefore critical for moving forward.
- **Market research:** Research led by IWMI has provided intelligence and insights into customer preferences and the nature of the market within which businesses are competing. Taking on the costs of this market research and channelling business development support based on market insights (for the preparation of business plans in particular) provide additional incentives for private sector actors to invest their own resources in such initiatives.
- **Encouraging policy uptake:** As waste valorization initiatives remain at an embryonic development stage, particularly in Ghana, there are opportunities for research institutions and CSOs to influence relevant policies and regulations. For such projects to be replicated, national government institutions should disseminate knowledge on the JV-type contract; support the preparation of municipal plans for sanitation; identify land and budget for acquisition and preparation; and assist partnerships among municipalities for larger facilities and steady supply of waste.

Approaches put forward in CapVal, institutional tools developed under the project and results achieved to date should be disseminated to national actors with the active participation of private and public actors who have contributed to the project's success.

1 INTRODUCTION

1.1 The Potential of Resource Recovery

In theory, resource recovery from waste has high potential for promoting circular economies, increasing cost recovery of sanitation services and improving livelihoods. With human activity increasingly depleting natural resources, leading to ecosystem disturbance, circular economies offer the opportunity to move away from the 'take, make, dispose' paradigm of production and consumption (Otoo and Drechsel 2018). In low- and middle-income countries, demand for resources, including for food and energy production, is high while reserves of non-renewable phosphorus, copper and zinc resources are declining. In this context, resource recovery from waste and its reuse holds great potential for meeting demand.

The sanitation sector is at the heart of any circular economy. It can facilitate waste management in ways that enable the recovery of resources and waste transformation into 'recycled' products. Where these resources and products hold financial value, they can also contribute to funding sanitation services with proceeds from by-product sales. This is particularly relevant in low- to middle-income countries where municipal budgets are often very low and sanitation services are underprioritized. Treatment, transformation and sales processes also hold potential economic benefits in the form of employment opportunities.

However, as for all economies, the circular economy, including the reuse of solid and fecal waste, needs to be financially sustainable. In other words, the costs of transforming waste and producing by-products need to be met. In contexts where public funds are limited, the prospect of market adoption of these by-products offers opportunities to actively involve the private sector in waste treatment and transformation and the commercialization of by-products.

Ongoing global research indicates that the private sector can play this role in the reuse economy. IWMI, in particular, has explored multiple approaches to develop resource recovery from waste with the specific aims of protecting ecosystems and to some extent supporting livelihoods. In 2018, IWMI published an extensive review of existing resource recovery businesses involving the private sector. Businesses related to solid fuel briquette production from agrowaste; biogas production from fecal sludge; power generation from manure; chemical products from agrowaste; and compost production from municipal waste, among others, were covered. All businesses demonstrated substantial potential of financial returns, with some businesses presenting a high Internal Rate of Return (IRR) on investment (Otoo and Drechsel 2018).

However, most businesses benefited from public support to establish and run the activities. Public support, including from national and local governments, as well as international organizations, came not only in the form of land provision, but also as capital investments for infrastructure and machinery acquisition. Businesses that did not use public support either operated at a very small scale using lost-cost technologies or implemented waste transformation reuse for internal purposes (e.g. power generation from the company's canteen food waste).

1.2 CapVal: Realizing the Potential of Resource Recovery in Ghana

In 2015, on the back of its previous experience in Ghana and its global research into resource recovery and reuse programs, IWMI initiated the CapVal project. CapVal began with Dutch funding via its local embassy under the Ghana water, sanitation and hygiene (WASH) window. This funding window called for PPP proposals for the development of water sanitation services (both solid and liquid waste sanitation). IWMI,

together with other local and international stakeholders (BOX 1), made a proposal towards a project that would support the commercialization of three products of fecal and solid waste resource recovery:

- Fertilizer produced from both fecal and organic solid waste;
- Fuel briquettes produced from organic solid waste; and
- Treated wastewater-fed fish culture.

These approaches were selected based on international experience and the potential in Ghana, which had been established through feasibility studies carried out by IWMI. The briquette business, in particular, appeared to hold notable commercialization potential.

BOX 1. Project partners.

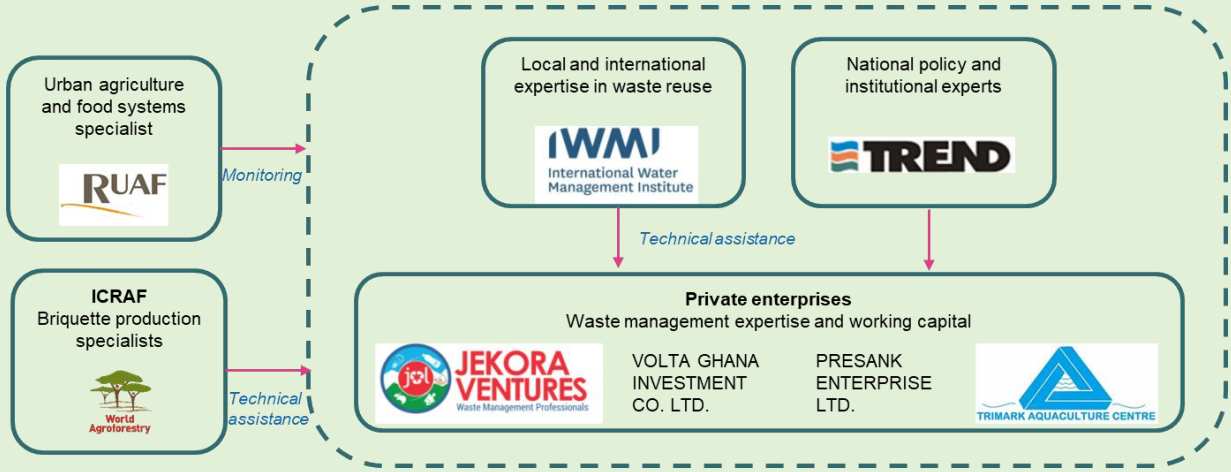
At the project proposal stage, IWMI partnered with TREND, a Ghanaian organization with a track record for facilitating engagement with stakeholders, including regulators and municipalities. TREND has also been involved with IWMI in a reuse project in Tema. Other key partners included:

- **Volta Ghana Investment Company Limited**, a local developer who offered to provide land for the construction of the briquette facility;
- **Presank Enterprise Limited**, a local waste management enterprise that would be in charge of the composting facility;
- **TriMark**, a local enterprise with experience in aqualculture; and
- **Jekora Ventures**, a local waste management enterprise that would be in charge of operating the briquette facility.

RUAF (the Global Partnership on Urban Agriculture and Food Systems), now part of the Hivos Foundation, would provide technical assistance and monitoring support to the project. The **World Agroforestry Centre (ICRAF)** would provide technical support on the briquette component (especially on production) given its extensive experience in this field.

The roles of different organizations involved are presented in FIGURE 1.

FIGURE 1. Roles of partners involved.



Sources: IWMI 2014, 2016, 2018, 2019, 2020, 2021.

Each of these by-products would be produced and commercialized under a PPP model, mobilizing both funding and expertise from public and private actors. Between 2015 and 2021, IWMI and partners carried out feasibility studies, identified suitable sites and partner municipalities, commissioned and oversaw work and further refined product concepts and business models, among other activities.

As of 2021, two PPPs had been established and facilities were delivering all three products. Facilities have not reached full production capacities and commercialization yet but are showing promising signs of achievement.

1.3 About This Report

This document extracts lessons from the CapVal project. It presents what was achieved between 2015 and 2021, highlighting institutional and financing arrangements as well as the underlying business models guiding the operations of each of the three production facilities (IWMI 2016, 2018, 2019, 2020, 2021). It showcases what interventions are needed to scale up fecal and solid waste resource recovery into viable businesses and assesses the impacts on key development indicators (including sanitation services themselves).

The document is aimed at a multiple audience. (1) To inform policy-makers and donors who seek to better understand the benefits (and risks) related to developing and investing in resource recovery and reuse. It also highlights the role of public funds for developing resource recovery from fecal and solid waste and what can be expected from the private sector in a context like Ghana; (2) researchers and practitioners by sharing some expertise on developing resource recovery facilities, what makes business models viable and highlighting the pitfalls that may prevent businesses from flourishing.

As a learning document it is based on an IWMI-commissioned review of project outcomes and lessons learned, which used project documentation and interviews with key stakeholders involved in the project (Annex 1). The discussion on the impact of the project, especially with regard to sanitation services improvement, is limited as no related survey was carried out.

The generic currency exchange rate used in the report (unless otherwise specified) is: GHS 1.00 = EUR 0.14385 as of May 2021 (www.oanda.com).

1.4 Structure

The remainder of this document is structured as follows:

- **Section 2** starts with presenting the results of the CapVal project or what had been achieved by 2021 in terms of infrastructure and production facilities; it also presents institutional and financing arrangements that underlie each production facility;
- **Section 3** identifies what constraints and barriers were encountered during the implementation process, from partner identification to land acquisition and regulations and how the project team responded to these challenges;
- **Section 4** reflects on the outcomes of the project on sanitation services, gender equity and job opportunities; and
- **Section 5** brings together the key lessons learned on the role of the public sector, on contract modalities for such re-use facilities and addressing wider challenges of commercialization.

2 CAPVAL: WHAT HAS BEEN ACHIEVED TO DATE?

Following a rapid overview of the businesses launched and their rationale in the context of Ghana, this section describes the three businesses that have been established, focusing on the infrastructure and technologies deployed, underlying institutional and financing arrangements and market results.

2.1 Overview

CapVal aims to integrate resource recovery and reuse for both liquid and solid wastes. Three potential waste-derived product groups were initiated: composting products from the combined treatment of dried fecal sludge and municipal solid waste, fuel briquettes from organic waste and fish cultured in treated wastewater (IWMI 2014, 2016, 2021).

When the CapVal project was initiated, the aim was to establish three distinct businesses operating from three different sites. The fuel briquette production facility was to be established in the city of Afienya (in the Ningo-Prampram district, east of the Greater Accra Region), while the co-composting facility would operate in Techiman (the capital city of the Techiman Municipal Assembly located in the Brong-Ahafo Region). Finally, the aquaculture facility was to be established in Kumasi, at a WWTP owned by the KMA.

By March 2021, the CapVal project had enabled the establishment of three production facilities in two sites (IWMI 2019, 2020, 2021).

2.2 Rationale in the Context of Ghana

These three businesses were launched primarily as a response to Ghana's sanitation challenges but also to address overreliance on fuelwood.

Ghana is one of Africa's leading economies, but sanitation remains a huge challenge in the country. While over 80% of the population does not have access to adequate sanitation facilities, the country lacks infrastructure for adequate transport and treatment of waste. The result is not only poor health for the population, but also environmental degradation. The high urbanization rate implies that pressure on sanitation services is only increasing.

The country is also one of the most advanced in Africa in terms of decentralization, but still needs to develop local government capacity to address sanitation. Local governments, also known as Metropolitan, Municipal, District Assemblies (MMDAs) plan on the basis of a 3-year cycle with budgets reviewed annually. They receive transfers from the central government and can also mobilize internally generated resources from local tax and other charges. Decentralization has also made MMDAs responsible for sanitation services. However, most MMDAs do not adequately plan and budget for sanitation services. Apart from the large MMDAs (such as Accra and Kumasi), resource allocations to sanitation remain very low. Sanitation is therefore seriously underfunded.

Ghana also grapples with solid waste management. Only a few municipalities have effectively allocated the land required and established treatment facilities that are managed adequately.

CapVal sought to contribute to addressing these sanitation challenges through waste by-product valorization. Key components of the project include:

- Small-scale capital investments, particularly in an FSTP that would also serve as a co-composting facility (composting both fecal sludge and organic solid waste);
- Supporting private sector participation in funding and managing the facilities, and showcasing what role they can play to enhance the provision of sanitation services; and
- Engaging with MMDAs to demonstrate the value of reuse for improving sanitation services (in addition to creating livelihoods) and develop their capacities so that they can fulfil their role in supporting these businesses.

CapVal also addresses the challenge of overreliance on fuelwood by introducing briquette fuel (BOX 2). Fuelwood constitutes about 40% of biomass energy in Ghana. Together with charcoal, they constitute two predominant sources of energy for cooking. The use of fuelwood and charcoal is beset with a myriad of adverse environmental and socioeconomic challenges due to the unsustainable nature of their production and use. They are linked to deforestation and climate change while incomplete combustion and smoke in particular when used in traditional and inefficient stoves, have health implications for the primary users who are mainly women (Kodua and Gebrezgabher 2018; IWMI 2019).

BOX 2. What are fuel briquettes?

Briquettes are solid fuel produced by compacting loose biomass residues (e.g. sawdust and rice husks) into solid blocks that can be burned for heat energy and can substitute for traditional biomass-based energy sources such as charcoal and fuelwood for domestic, commercial and institutional cooking as well as industrial heating processes. Converting biomass wastes into briquette fuel has the potential to enhance sustainable development while raising the living standards for the poor in developing countries (Ngusale et al. 2014). Biomass briquettes are not common in Ghana and can therefore be considered as an emerging source of heating energy (FIGURE 2).

Source: Kodua and Gebrezgabher 2018.

FIGURE 2. Briquettes manufactured in Somanya (Ghana).

Photos: Nartey, E. and Agbefu, D. 2021.

2.3 Compost and Briquette Businesses

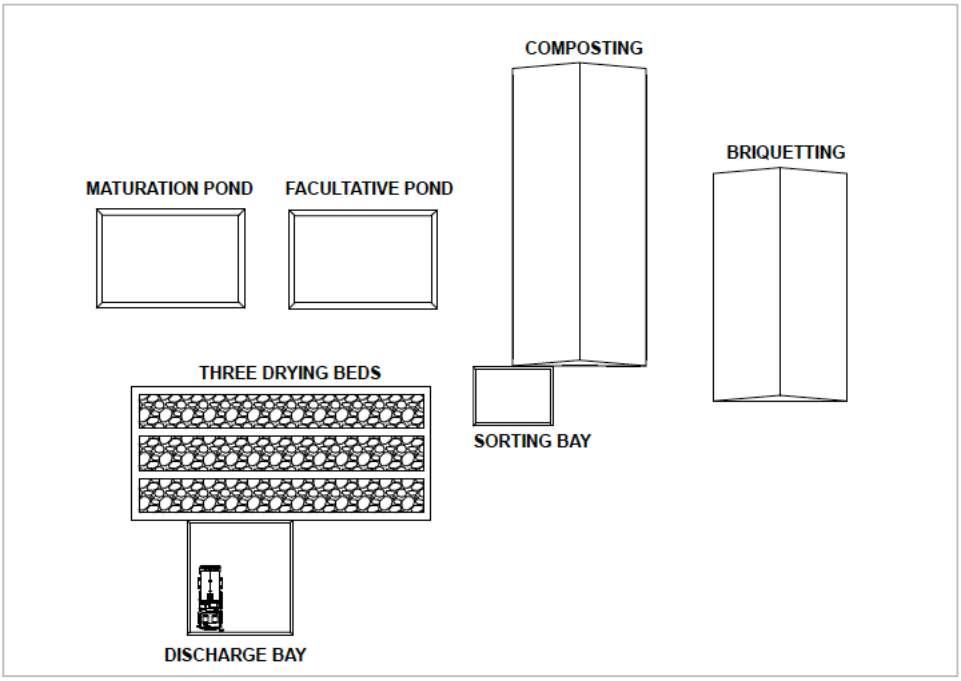
2.3.1 System Process and Technology

The composting business operates a facility installed at Akorley near Somanya, the administrative capital of the YKMA. Launched in September 2020, the facility has a theoretical production capacity of 200 tonnes annually. It can transform up to 5,000 m^3 of fecal sludge and 300 tonnes of organic solid waste per year. Fecal waste is sourced from private and public onsite sanitation systems (pit latrines and septic tanks) in nearby communities and organic waste from local markets (mainly fruits and vegetables), poultry farms and sawmills.

The FSTP constructed under CapVal is the first of its kind in Yilo Krobo, a municipality of about 100,000 people. The treatment facility has two main systems: a decentralized treatment system and a co-composting unit (FIGURE 3). The fecal sludge treatment scheme involves primary and secondary treatment measures. The incoming fecal sludge is filtered and the influent is gravity-fed to three sand drying beds. The liquid effluent is then conveyed into two stabilization ponds for secondary treatment. The final effluent is retained in the maturation pond and used for irrigation activities. The dried fecal sludge separated in the drying beds is co-

composted with organic waste in the plant's secondary structure. The second unit includes a sorting phase for organic waste, followed by aerobic pile composting, in which the food waste and dried fecal sludge are co-composted in a 3:1 mass ratio into the final product.

FIGURE 3. Layout of the FSTP in Somanya.



Source: IWMI 2021.

The manufactured product is a co-compost. IWMI had developed and supported the commercialization of a similar product under the Waste to Food (WaFo) project (**BOX 3**) (IWMI 2017).

BOX 3. Compost production in the WaFo project.

IWMI has been pioneering research on resource recovery and reuse of organic solid waste, fecal sludge (FS) and sewage wastewater since 2001. In Ghana, the work started with assessment of the nutrient recycling loop model as well as the demand, supply, technical and institutional issues surrounding waste recycling and reuse As a result, IWMI has acquired extensive knowledge on waste-based fertilizer production (production of compost, organo-mineral fertilizer or compost pellets) and water reuse for irrigation and aquaculture. In 2013, IWMI with joint financial support from the Bill & Melinda Gates Foundation, Grand Challenges Canada and the UK's Department for International Development launched the WaFo project to produce an FS-based fertilizer material (Fortifer) for distribution in Ghana. The Fortifer plant is sited at the FSTP in Tema Metropolitan Assembly (TMA). The WaFo project also involved the establishment of a PPP in the form of a JV agreement. Jekora Venture Limited (JVL) is the private operator involved. The main result from this project has been the first certification of FS-based compost with the Ministry of Food and Agriculture (MoFA) in Ghana.

Source: IWMI 2017.

Akorley (near Somanya) is also home to the briquette production facility. Operating on the same site as the composting facility (FIGURE 3), the briquette business has a theoretical production capacity of 1,000 tonnes per year. The facility started operating in January 2021. Production has four phases: crushing, briquetting, cooling and bagging. The briquettes are composed of sawdust and wood shavings (rice husks are planned to

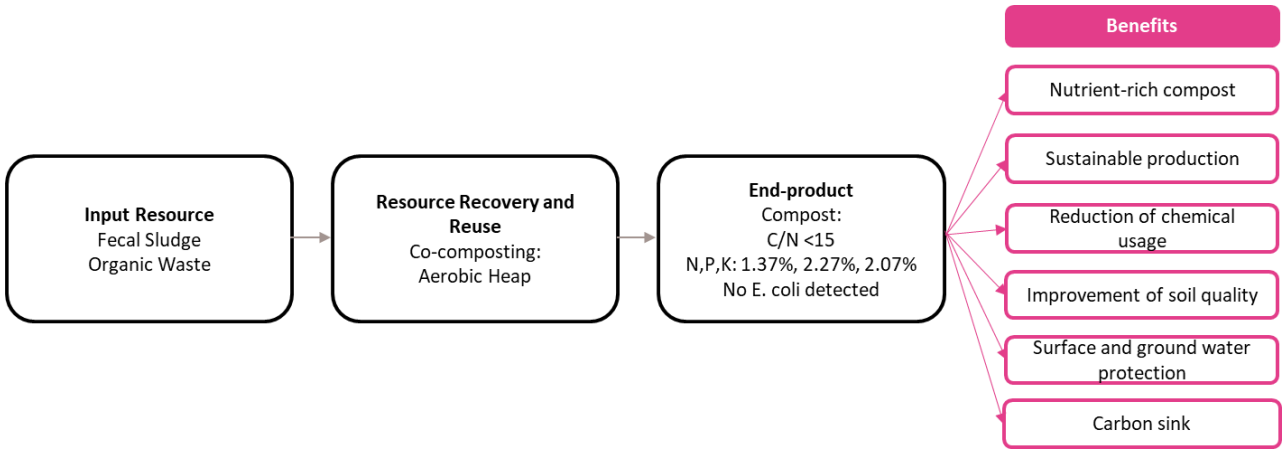
be added as well), and the waste fractions are collected from neighboring areas. As part of the test run, a drying process has been introduced to further reduce the moisture content of the raw material. The optimum moisture content for the briquette is 8% to 10%.

As of 2021, both businesses employed 17 people comprising 13 men and 4 women. The facility is managed by a woman.

2.3.2 Value Proposition and Market Potential

The composting business: The compost product is positioned as a nutrient-rich product, unique in its capacity to support efficient crop growth, whilst protecting ecosystems (FIGURE 4). The product has been specifically designed to support local crop production (such as mango, cabbage, pepper, maize, tomatoes, lettuce and so forth). Compared with competing non-organic products, the compost provides a sustainable source of fertilizer. It is launched in an area (Yilo Krobo) where access to such quality organic product is not well developed.

FIGURE 4. Compost value proposition.



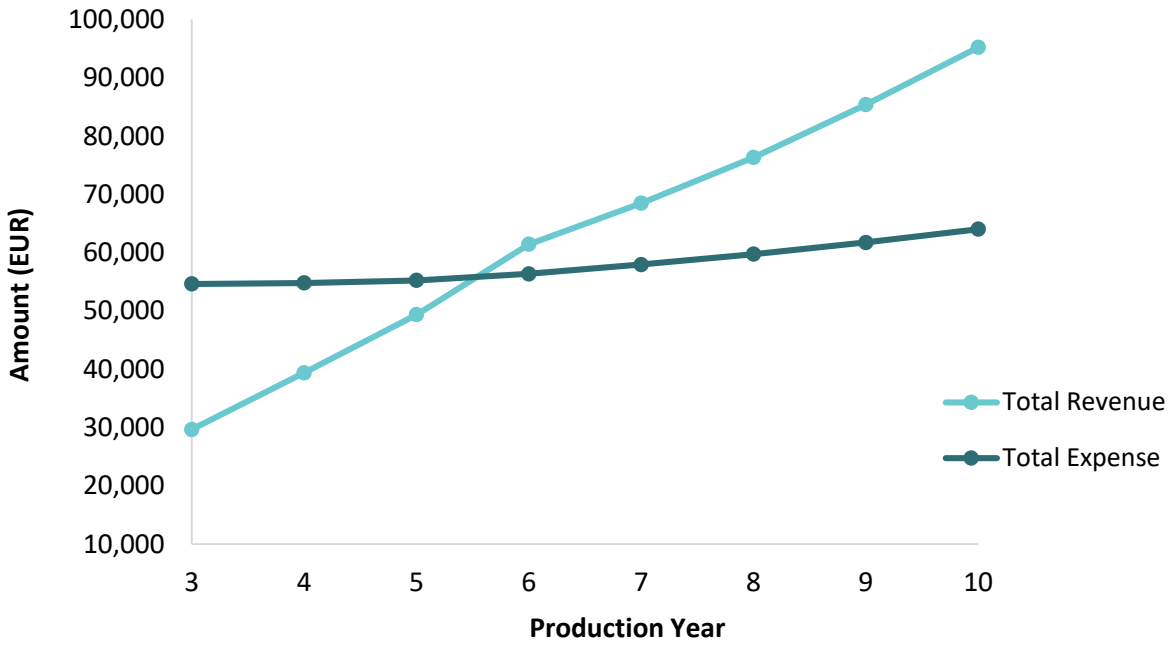
Source: IWMI 2020, 2021

According to the business model for compost production, the joint venture should break even after Year 5 of production (FIGURE 5). Break-even should be driven by an increase in revenue, linked to price increase. The business model estimates that by Year 3, the price of compost will amount to EUR 0.25 per kilogram (kg) and will increase by 11.9% per annum to reach EUR 0.55/kg.

It should be noted, however, that calculations do not take into account any depreciation. In practice, the business will also be liable to renewing some assets and small investments in infrastructure maintenance (including the access road, FSTP grounds and components). Projections do take into account expenditures related to facility maintenance and operations.

In addition, competition with other products, including inorganic fertilizer, is strong. Price projections for the compost are based on the cost of production and comparison with other fertilizers on the market. Prices of fertilizers in the market in 2020 are provided in TABLE 1.

FIGURE 5. Revenues vs expenditures of the compost business.



Source: Authors, based on the IWMI-JVL business model for the composting plant (IWMI 2020).

TABLE 1. Fertilizer price comparison.

Fertilizer	Price/kg (EUR)
Government	0.43
Planting for Food and Jobs (PFJ)*	0.25
Open market (including inorganic fertilizer)	0.53
Accra Compost and Recycling Plant (ACARP)	0.05 (to distributors) 0.07 (open market or from retail shops)
JVL (CapVal) co-compost	0.10

Source: Authors, based on interviews.
Note: PFJ has different suppliers, including inorganic and organic compost producers.

The profitability of compost production however lies in the scale of production and taking advantage of the facility to produce more. Increasing the scale of production could also put the facility in a position to be considered as a supplier of compost and as part of the national fertilizer subsidy program (**BOX 4**).

The briquettes business: Briquettes produced by JVL can be positioned as an alternative 'cleaner fuel' to charcoal and other wood-based fuel. Produced using waste from wood residues, the business contributes to reducing deforestation and can therefore be an attractive product for small-scale industries and business activities looking to use environmentally friendly alternatives. As of January 2021, the facility is the second in Ghana to provide non-carbonized briquettes for use in industry. From the outset, the project excluded widespread adoption by households, which have easy and reliable access to charcoal. The scale of the briquette business does not involve widespread distribution at the household level and therefore direct competition with charcoal. Non-carbonized briquettes produce high amounts of fine particulate matter and hence household use would require very efficient stoves (Njenga at al. 2013). However, market research indicates a strong potential uptake with industries. With some of them shifting from residual fuel oil to the use of biomass boilers, the availability of briquettes is a welcome intervention.

BOX 4. The Government of Ghana 'Fertiliser Subsidy Programme'.

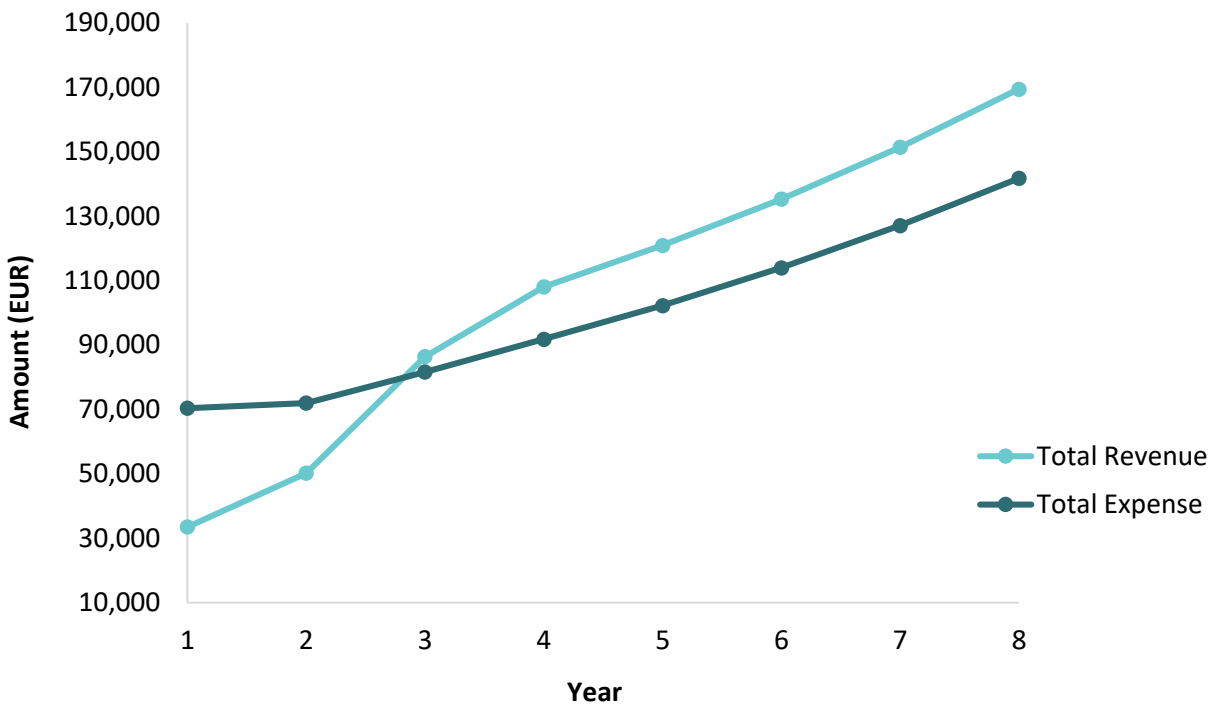
As part of efforts to enhance agricultural productivity and provide support to farmers, the Government of Ghana instituted the national fertilizer subsidy program. It provides fertilizer to eligible farmers at a subsidized cost (50% price cut). Since 2017, the program has been incorporated into the PFJ program. The fertilizer subsidy applies both to organic and inorganic fertilizers and producers of organic fertilizer qualify for their products to be purchased by the government as part of the scheme. The limitation however is that the suppliers of organic fertilizer should be able to supply more than 5,000 tonnes per year to quality for the scheme. This means that only large companies producing large quantities can qualify, thereby eliminating smaller producers such as the JV-managed facility in Somanya, which has the capacity to produce up to 200 tonnes in a year. There are currently two organic fertilizer suppliers, ACARP Ltd. and Yayra Glover Ltd.

Sources: Ministry of Food and Agriculture 2021; M. Annan 2021 (personal communication).

JVL has identified a potential company ready to sign a sales contract. It is discussing a fuel supply agreement with a locally-based textile manufacturer. However, this means that the facility will have to step up production to provide fuel in sufficient quantity. In order to adapt to the demand, the company is planning capacity expansion, mainly by extending the working period beyond the current 8-hour shift and the acquisition of an additional production unit, which will require some capital.

The business model for the briquette plant expects break-even by Year 3 of activities, when the sale of briquettes is expected to reach 750 tonnes (FIGURE 6). Growth is driven by a gradual increase in sales volume (up to 1,000 tonnes a year according to production capacity) and a price increase. At Year 3, the price per tonne is expected to be EUR 81 and will then increase by 11.9% annually.

FIGURE 6. Potential revenue generation.



Source: Authors, based on the IWMI-JVL business model for the briquette plant (IWMI 2020).

Regarding compost sales and revenue projections, these projections do not take into account depreciation costs, where assets rehabilitation and/or renewal are likely to be necessary in the coming years. Projections do take into account expenditures related to facilities' maintenance and operations.

2.3.3 Institutional Arrangements

The composting plant is operated by JVL under a JV agreement with YKMA. The JV agreement, signed in 2020, is a 20-year agreement between JVL and YKMA. It grants ownership of the facilities (both the compost and briquette facilities) to JVL and YKMA, including land, infrastructure and machinery).

Under the agreement, JVL ('the managing partner') is in charge of all operations (plants and sales) and covers all operational costs. As a partner, JVL is entitled to:

- Exclusive access to the site;
- Conclude contracts with cesspit emptiers and waste generators (if required);
- Receive tipping fees; and
- Enter into contracts or sales agreements with compost and briquette clients.

The JV agreement also allocates strong responsibilities to YKMA. Among them, the municipality has to provide four acres of land in an accessible and non-flood prone area. In fact, YKMA has acquired the land for about GHS 92,000 (EUR 13,350), demonstrating strong commitment to the project. Another important role of YKMA is to ensure the constant supply of adequate and appropriate quantities of fecal sludge and solid waste and other raw materials required for the production of the compost and briquettes. YKMA has also been tasked with supplying basic infrastructure for the plant to operate, including an access road, water and electricity. In practice, this requires YKMA to enact and enforce sanitation by-laws, ensuring that household and public toilets are adequately emptied and the sludge is dumped at the FSTP, which is the only dedicated plant in the area. The existing sanitation by-laws are yet to be updated as YKMA is still in the process of drafting the law. In addition, discussion with YKMA has indicated that the limited capacity of the plant to receive waste produced in YKMA is a barrier to the enforcement of such a by-law.

Both parties are responsible for future extraordinary repair and capital maintenance. As a JV agreement, this PPP entails co-ownership of the assets over the 20-year agreement period and therefore joint responsibility for capital maintenance.

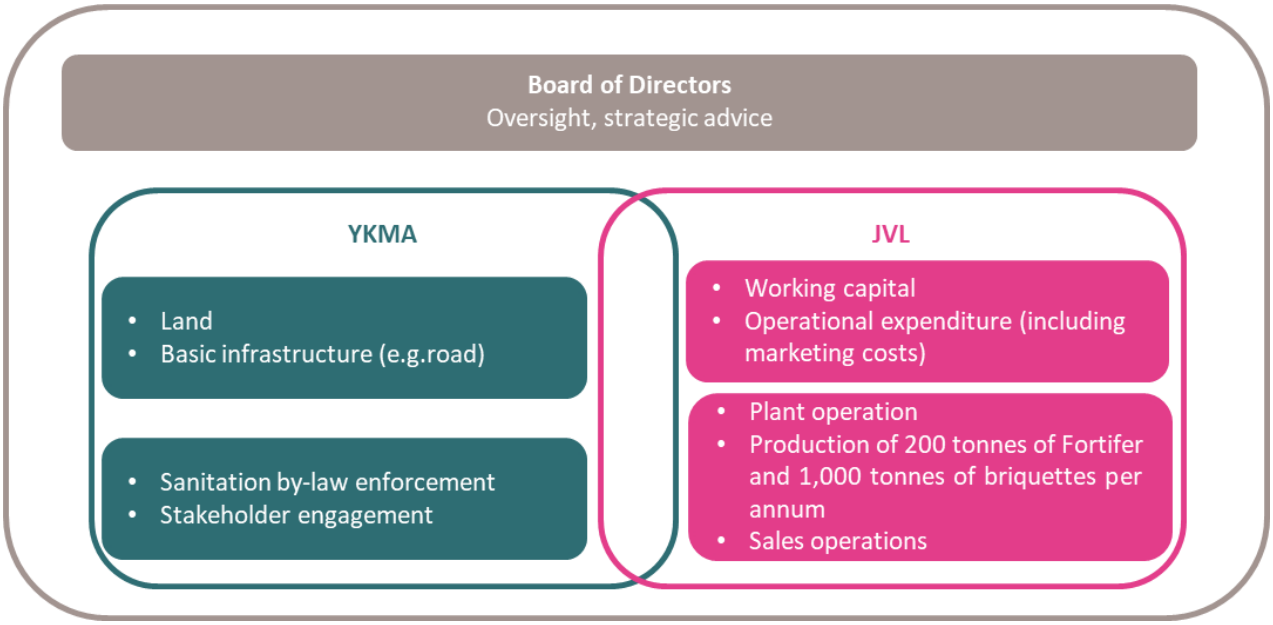
In order to facilitate decision-making with regard to critical business decisions, the JV agreement calls on a Board of Directors to be formed. The Board includes representations from JVL, YKMA and three or five other appointees and is headed by a Chairperson. Its role is to exercise oversight over the JV to ensure that partners deliver on their obligations. Its functions include:

- Approval of top management staff for the JV business;
- Formulation of corporate policy; and
- Provision of strategic directions for company growth.

FIGURE 7 provides an overview of JV partners' responsibilities.

The Ministry of Sanitation and Water Resources is a 'witness' to the agreement. The JV has also been approved by the Ministry of Local Government and Rural Development, which is in charge of all local government matters. To date, however, there has been limited engagement with these two ministries on contract implementation.

FIGURE 7. Responsibilities under the JV agreement for the compost and briquette plants.



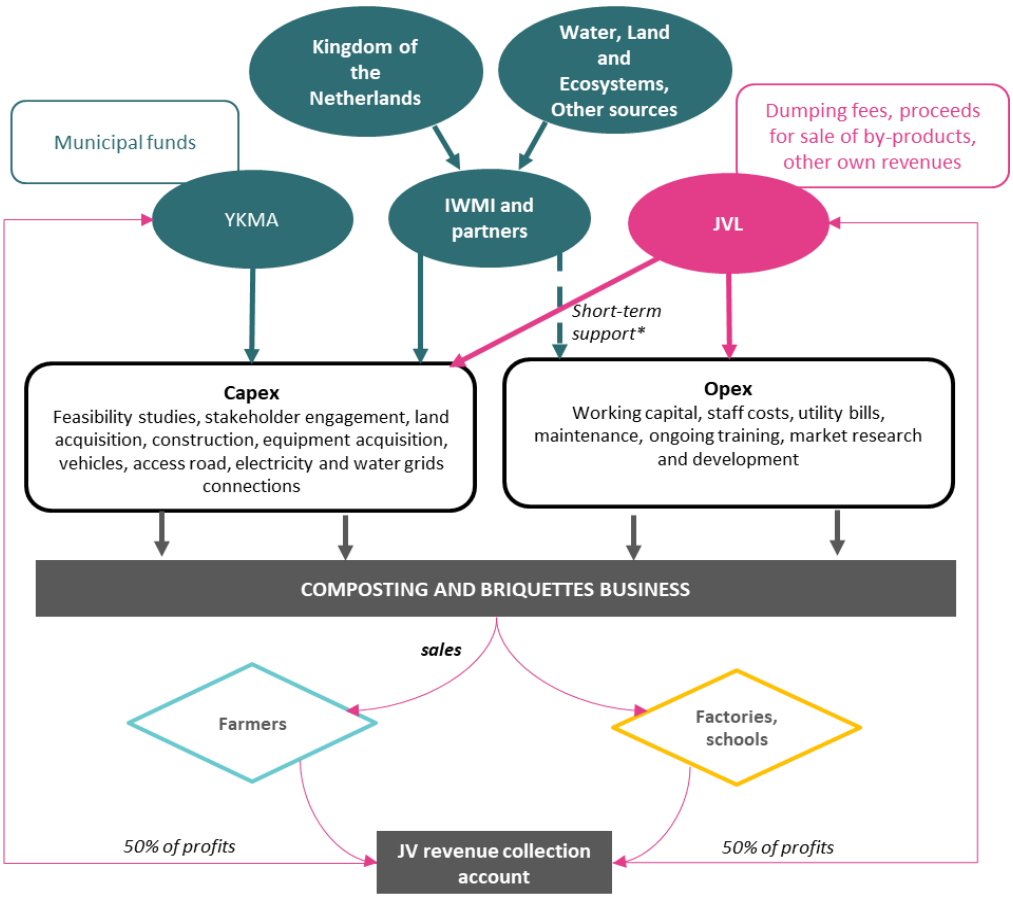
Sources: IWMI 2020, 2021.

2.3.4 Funding Arrangements

Funding for the establishment and operation of the treatment and production plant comes from a mixture of public and private funds, with all initial capital expenditure coming from public donors. IWMI and project partners, together with YKMA, have covered all capital investments, from feasibility studies to construction and mains connections (FIGURE 8). The private enterprise (JVL) is in charge of all operational expenditures, including the initial working capital. However, as co-owner JVL holds joint responsibility for capital maintenance after construction.

The total capital costs (hardware only) for both the briquette and compost plants amounts to EUR 322,950 to date. The largest contributor to these costs has been IWMI and partners (mainly funding from the Netherlands Ministry of Foreign Affairs and to a smaller extent the Water, Land and Ecosystem research program of the CGIAR), with contributions representing 87% of total costs. YKMA contributed abut 8% mainly in land and grid connections. YKMA financed the installation of water and electricity to the site (end-of-pipe connections from Ghana Water Company Ltd., a transformer and connection to the main power lines). JVL contributed about 6%, mainly to acquire 'bola' taxis (used for solid waste collection, FIGURE 9) as well as small site adaptation and clearance needs after construction. JVL is also contributing via working capital as it is covering staff costs and recurring expenses. JVL is planning to invest in an additional solid waste collection truck for the briquette component as well as a mechanical compost turner. FIGURE 10 presents a heap of compost during maturation.

FIGURE 8. Funding model of construction and operation for the briquette and compost plant.



**IWMI's support to be phased out after year 1 of operations.*
Note: JV is the abbreviation for 'Joint Venture'.
Sources: IWMI 2014, 2019, 2020, 2021.

FIGURE 9. A bola taxi in front of the composting facility.

FIGURE 10. Maturing compost.

Photos: Nartey, E. and Agbefu, D. (2021).

However, a project such as CapVal also comes with other hidden costs as it introduces new products into the market. These relate to, *inter alia*:

- Enforcement and sensitization costs, which are borne by the municipality: these relate to enforcing by-laws to promote adequate emptying practices and incentivize dumping at the designated FSTP;
- Stakeholder engagement to promote partnerships where needed (such as between YKMA and the Lower Manya Krobo Municipal Assembly and also between the operator and the community/sources of waste), and to obtain necessary permits and certificates to establish and run the production facility;
- Capacity development for YKMA and the staff working at the facility; and
- Market research and development to identify customers, sales and marketing approaches and to develop workable business models.

The briquettes and composting business did not benefit from a tax waiver as planned at the start of the project. Applications for tax waivers at the construction stage were not approved because the project did not meet waiver criteria. Furthermore, YKMA was not able to request support from the national One District One Factory (1D1F) initiative, which seeks to incentivize the establishment of industries and factories via incentives such as tax exemptions.[1] YKMA is still exploring tax break opportunities.

According to the JV agreement, all revenues from the business have to be deposited in a special account. Once the business breaks even, then both JV partners are entitled to equal shares of the profits.

2.3.5 Production and Market Results to Date

As of 2021, the Akorley (Somanya) plant had not yet reached full production capacity (as planned) and did not have any sales results. As detailed below, efforts were still being deployed, with financial and technical support from IWMI and partners, for optimizing production and for marketing and commercializing the products.

***Compost*.** In January 2021, the facility had received and treated 255 cubic meters (m^3) of fecal sludge and 114 tonnes of solid waste, for a 1- and 3-month operational period respectively. The volume of compost available for sale as of March 2021 was still small (only 20 tonnes of compost produced) and most of the compost batches were at the curing stage and not ready for sale. Once collected and sorted, waste needs about 3 months before it is ready to be sold as compost.

Project partners have already carried out engagement meetings with potential off-takers, including greenhouse and conventional farmers, particularly mango seedling growers, rice farmers and vegetable farmers within Somanya and neighboring farming communities. Engagement planned with potential customers includes farmers visiting the treatment plant so that they better understand the product and production processes and the establishment of demonstration farm sites.

***Briquettes*.** The facility started piloting feedstock collection for briquette production from October 2020. In January 2021, 97 tonnes of wood waste had been collected. The capacity of the plant is about 600 to 700 kg per hour, depending on feedsock characteristics. Production is behind schedule due to the COVID-19 pandemic, which has caused delays in machine installation and test runs to optimize briquette production, which only started in 2021. Tests are planned to be carried out throughout 2021 to optimize the production process (e.g. the waste feed drying period and machinery calibration) as well as to assess the potential of alternatives to wood-based waste feed, such as rice husks. Indeed, briquette production may be affected by seasonality (and the shortage of wood waste) and rice husks are considered as alternatives. It is planned to

[1] The 1D1F initiative is a Government of Ghana policy that was started in 2017. It aims to incentivize the establishment of facilities strategically in districts where raw materials are available, leading to job creation. Government support includes facilitating access to finance from financial institutions, advisory support to establish factories and tax exemptions where applicable (One District One Factory [1D1F] 2020).

assess the resulting briquettes in terms of visual aspect, burning rate, calorific value, ash content, moisture content, fixed carbon and other features. Engagement with potential off-takers is also progressing, with one large industry indicating interest in adopting the fuel.

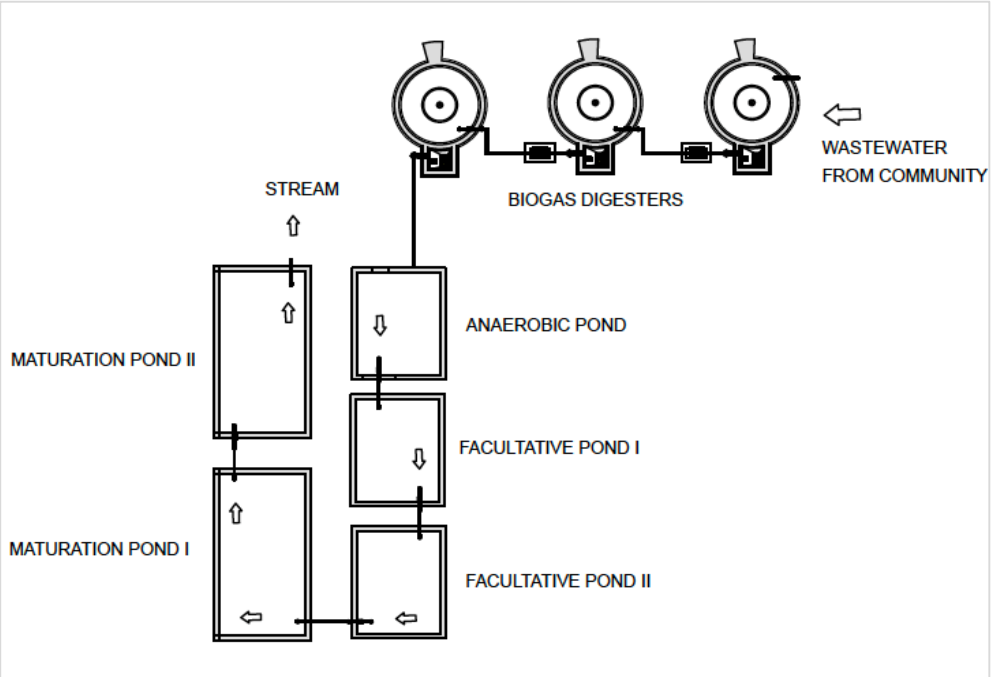
2.4 The Aquaculture Business

2.4.1 Infrastructure and Equipment

The aquaculture business operates from the grounds of a WWTP in Kumasi. IWMI had been testing fish production in Kumasi since 2012 (Amoah et al., 2021) and, with CapVal, the research institute and partners intended to take production to the commercialization stage (Amoah et al., 2021). One of the largest metropolitan areas in Ghana, Kumasi is home to 3.3 million people. The Chirapatre WWTP is one of the five small-scale WWTPs owned and operated by the KMA, the local authority. The WWTP receives about 30 m^3 per day, serving an estimated 1,800 people. All wastewater comes from households in the Chirapatre Estate.

The aquaculture business produces three main products derived from African catfish (*Clarias gariepinus*). It produces broodstock for breeding, fingerlings for farmers and fish cultured in groundwater for consumption. Each of these products represents a different business line. Chirapatre WWTP was enhanced to include three biogas digesters to improve treatment before discharge into the last two treatment ponds where the broodstock is produced. This component uses the nutrient-rich wastewater to produce breeding fish that deliver fingerlings in onsite hatcheries. Treated wastewater ponds are only used to grow the broodstock. Some fingerlings produced in the hatcheries are transferred to onsite concrete tanks where they are allowed to mature in fresh underground water. FIGURE 11 presents the layout of the WWTP site.

FIGURE 11. Layout of the WWTP and aquaculture system.



Sources: IWMI 2019, 2020, 2021; Amoah et al., 2021.

Vegetables are also produced in a greenhouse. Wastewater generated from the hatcheries and the onsite concrete fish culture tanks, which are both fed with groundwater, is channelled to the greenhouse for

vegetable production. An aquaponic system has been installed in the greenhouse to take advantage of the nutrient-rich water from the fish ponds to grow vegetables. Aquaponic systems provide efficient use of water for growing food and use less water to produce food compared to traditional farming systems. In addition, the system uses organic and natural nutrients from the fish at no additional cost. The vegetables produced are free from herbicides and pesticides. The sales from the vegetables further add to the diversity of revenue sources for the facility making it more sustainable.

The business started with two staff and gradually grew. In 2021, staff comprised four men and four women. The company has a policy to encourage the engagement of women, who usually work in the hatcheries, while men focus on groundskeeping and pond management.

2.4.2 Value Proposition and Market Potential

Catfish is a sought-after product, commonly used by local restaurants ('chopbars'). Increasing demand for catfish coupled with low production provide opportunities for fish farmers (IWMI 2014, 2016, 2018). The location of the facility in Kumasi is a bonus as Kumasi is one of the most important fish markets in Ghana (Awity 2021). Ideally situated at a central location in the city, the facility is close to local markets and restaurants. For table-size fish, the manager of the facility indicated that they only sell smoked fish, a process that also removes pathogens, if any, from the fish. The only limitation of selling the smoked product is the lower cost (EUR 1.89 per kilogram) while fresh fish fetch EUR 2.61 per kilogram. However, according to the women vendors, smoked fish has a longer market life than fresh fish. This was confirmed by an FAO National Aquaculture Sector overview, which indicated that smoked fish, which has been stored for 3 to 6 months, is common in some markets in Ghana.

IWMI and partners led studies to investigate consumers' perceptions of fish farming using treated wastewater and consumers' willingness to purchase such fish in Kumasi, Ghana. A dichotomous-choice contingent valuation methodology was used to analyze factors that affected consumer choice. Results revealed that consumers of fish in Kumasi generally had no objections to purchasing fish reared in treated wastewater. However, they were more likely to choose fish farmed in treated wastewater if the fish were cheaper than counterparts on sale.

2.4.3 Institutional Arrangements

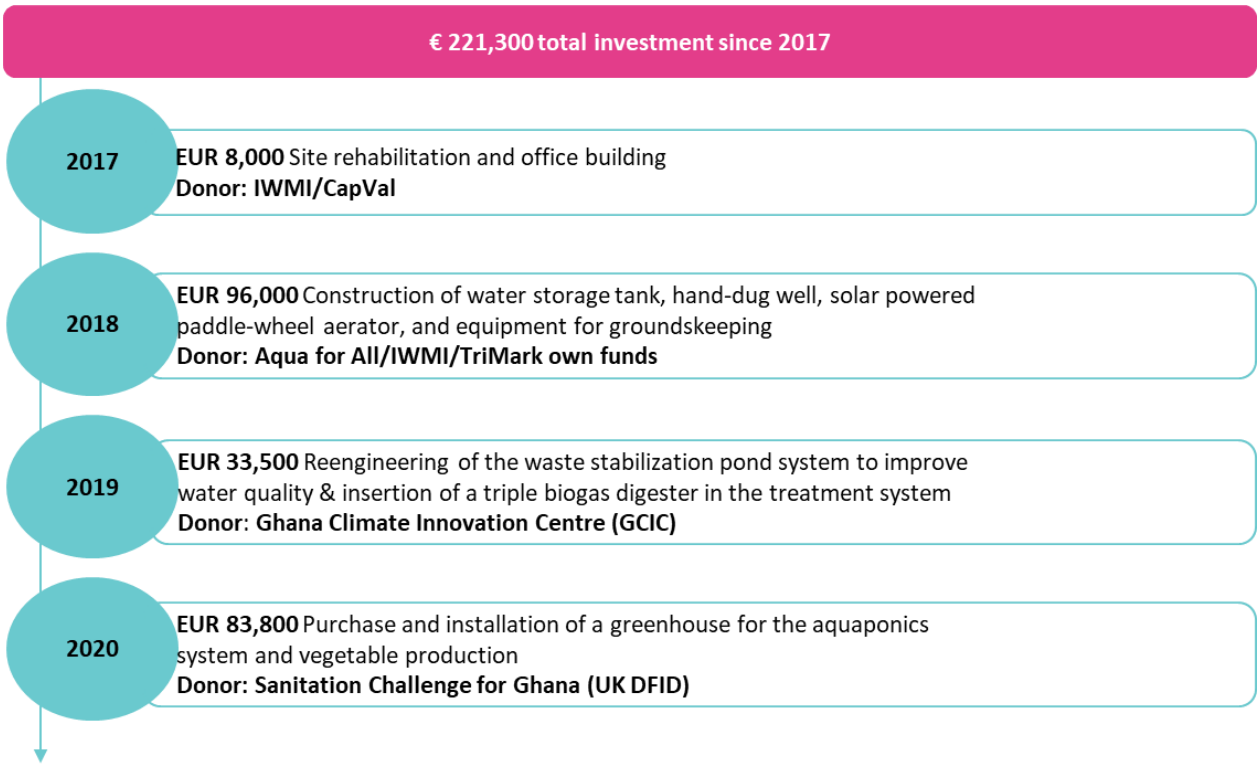
The aquaculture facility is managed by a local small private company, TriMark under a JV agreement with KMA. Signed in 2018, the 15-year agreement is similar to the one signed between JVL and YKMA whereby both parties are co-owners of all assets. In terms of rights and responsibilities, the JV agreement provides the private company with exclusive right to access, use the WWTP for aquaculture production and sell the products. KMA must provide the land, ensure the effective management of the sewer line and supply adequate amounts of wastewater for fish production. The main incentive for KMA is to ensure that the facility is well managed. The revenue generation from the fish sales is an added incentive.

The JV in Kumasi is also governed by a Board of Directors (BoD). Most functions are similar to the JV with YKMA. However, the BoD is also tasked to undertake "mediation on behalf of the project and its stakeholders to ensure smooth operation of the business". It should also be noted that members of the project (IWMI and TREND) shall cease to be part of the BoD once the project is over. However, no clause identifies how they will be replaced. To date, IWMI has played a key role in dispute resolution; however, as the project phases out, there is a risk that the role will not be continued after IWMI's departure. A balanced and credible BoD may help to mitigate such a risk.

2.4.4 Funding Arrangements

According to the JV agreement, at project inception, the private company was only in charge of covering the costs of O&M of the facilities. Once facilities were operational responsibilities for maintenance and enhancement of the facility would lie with both partners. To date, however, all enhancement has been conducted by TriMark. FIGURE 12 summarizes the gradual enhancement of the WWTP site to enable the aquaculture business to develop.

FIGURE 12. Investment made to date at the Chirapatre WWTP.



Sources: IWMI 2016, 2019, 2020, 2021.

As shown in FIGURE 12, of the EUR 221,000 invested since 2017, CapVal directly contributed about EUR 18,000 mainly for minor rehabilitation works and construction of an office, a hatchery and depuration tanks. The initiative has attracted contributions from multiple donors to further enhance the business model. Aqua for All granted funds for the construction of freshwater ponds and an associated borehole. The Ghana Climate Innovation Centre granted funds for reengineering the waste stabilization pond system and a triple biogas digester. In 2020, TriMark won the first prize of the Sanitation Challenge for Ghana (a UK Aid-funded initiative), which enabled the purchase and installation of the greenhouse for the aquaponics system.

Conversely, there is no record of any investment carried out by KMA. To date, all capital has been sourced from donors. KMA has provided in-kind contributions only, with the provision of land for aquaculture and crop production. Considering the extent of TriMark's investments, there is a question as to whether the 15-year duration of the JV agreement is sufficient for TriMark to recover the investments and there is no guarantee that the JV will be extended beyond this timeframe.A review of the agreement may be necessary.

All revenues from the sale of fish are transferred to a Revenue Collection Account, similar to the briquette and composting businesses.

2.4.5 Production and Market Results to Date

As of 2021, TriMark was re-initiating production that had been interrupted by the COVID-19 crisis. Production was affected by the lack of staff (as the government ordered lockdown). Due to the unknown nature of the virus, there was also a fear from TriMark that wastewater, which possibly carried the virus, might be unsafe for fish culture. However, literature review and tests run by IWMI confirmed that production could resume and fish would be safe for consumption.

Prior to 2020/2021, the business was slowly increasing production capacity (TABLE 2). In 2019, the business sold 3,800 kg of mature fish and this translated into an increase in revenue (EUR 6,301). As shown in TABLE 3, total expenditure remained quite high and the profit margin was relatively low. Losses in 2020 due to the COVID-19 pandemic were significant. They were incurred as the facility could not be used, leading to product loss and disruption of sales during lockdown.

TABLE 2. Fish production since commencement of the project.

Product	Fingerlings		Table-size fish	
Production year	Number of fingerlings produced	Number of fingerlings sold	Amount produced (kg)	Amount sold (kg)
1. 2018	34,600	21,000	8,400	3,400
2. 2019	58,500	33,000	10,200	3,800
3. 2020	-	-	-	-

Sources: IWMI 2019, 2020, 2021; Amoah et al., 2021.
Note: Some fingerlings were retained for the production of table-size fish and broodstock.

TABLE 3. Operating expenditure and revenue.

Production year	Expenditure		Revenue	
	GHS	EUR	GHS	EUR
1. 2018	23,860	4,286.88	36,900	6,629.75
2. 2019	40,300	6,301.19	50,500	7,896.03
3. 2020	84,085	13,232.54	15,000	2,360.57

Sources: IWMI 2019, 2020, 2021; Amoah et al., 2021.
Note: 2020 production was affected by the COVID-19 pandemic. Fish production stopped in March 2020 when a lockdown was imposed in Ghana. Exchange rates: 2018 – GHS 1.00 = EUR 0.17967; 2019 – GHS 1.00 = EUR 0.15636; 2020 – GHS 1.00 = EUR 0.15737.

3 ADDRESSING CONSTRAINTS TO INCREASE RESOURCE RECOVERY AT SCALE

The CapVal project highlights a number of challenges and constraints that can be faced when initiating resource recovery activities. This section presents these challenges and how CapVal addressed them.

3.1 Land Acquisition

The availability of land has been an issue for the briquette business in particular. At the start of the project, in 2015, the composting and briquette businesses were to be established in two different locations: the composting facility in Techiman (a municipality in the center of the country) and the briquettes in Afienya (a municipality near Tema). With regard to the briquette facility, a private partner (Volta Ghana Investment Company Limited [VGICL]) was to provide the land, which would then be operated by JVL; however, Volta Ghana was facing litigation issues over landownership and could not secure the land required for the project to take off in a timely manner. With time passing, IWMI and partners decided to seek out different partners and sites for the briquette facility.

Working capital required from private partners was also an issue for the composting facility. The private partner (Presank Ltd.) withdrew from the project because of lack of funds and their inability to meet their required contribution for the partnership.

These setbacks led to IWMI and partners identifying new municipal partners to establish the businesses. This created delays in the project, but also required additional resources for new feasibility studies on the proposed land (particularly compliance with environmental regulations pertaining to using the land for waste management) and the market potential for compost and briquettes in the area. Additional – and unforeseen – resources were deployed for stakeholder engagement, particularly with YKMA.

This experience clearly reveals one of the biggest challenges to establishing adequate waste management facilities: land availability. Municipalities are in charge of both solid and liquid waste management; yet few have allocated land for this purpose in their planning. This lack of land is a challenge for establishing waste management businesses and can cause significant delays.

3.2 Regulations

Achieving compliance with environmental and food safety regulations was a major hurdle to enable products to be launched in local markets. Work on compliance concerned:

- Environmental impact assessments for obtaining permits for construction of waste management sites;
- MoFA regulations regarding composting;
- Ministry of Energy regulations to certify briquettes as sources of energy;
- Certification by the Fisheries Commission of Ghana indicating that treated wastewater-fed fish were safe for consumption; and
- The Food and Drugs Authority had to approve the facility as a site for food production.

IWMI and partners succeeded in addressing these regulation issues through engagement with the regulatory agencies. This project was the first in Ghana to engage with regulatory agencies to certify processes for producing fish from treated wastewater for human consumption.

The processes of seeking certifications were also beneficial for the businesses themselves. For example, the Fisheries Commission of Ghana, the regulatory body in charge of management of the fisheries resources in Ghana, visited the plant in Kumasi and declared their support for the concept of fish production from treated wastewater. However, the Commission thought that the fish product might have difficulty in competing with rivals. It believed that the typical Ghanaian customer would object to eating fish from wastewater (even if treated) and competitors could leverage this against the product. The Commision suggested that TriMark should modify the business model by focusing on three main products, with three main revenue streams: broodstock and fingerlings grown in treated wastewater and fish cultured in clean water for consumption. The Commission highlighted strong demand for fingerlings and broodstocks.

3.3 Identifying Partners

Supporting the development of reuse businesses requires willing partners from the public and private sector, although the level of engagement of the public sector varies depending on the type of business.

In the initial establishment of CapVal, private entities were the most pro-active partners, especially for the briquette plant. Land was to be provided by a private landlord (VGICL), and the facility operated by JVL. Municipalities were secondary partners not yet actively engaged in the process.

Although the project started with four private partners, only two have remained involved, JVL (BOX 5) and TriMark. Both companies had prior experience of collaboration with IWMI. The company that originally partnered to manage the compost facility (Presank Ltd.) withdrew over concerns regarding financial commitments.

JVL was then instrumental in identifying the municipality where the compost and briquette facility would eventually be established. The private company played a key role in identifying the partner municipality. Criteria for selection included land availability, willingness to purchase and prepare the land and commitment to the project concept. YKMA proved to be a suitable partner as evidenced by investments carried out to date.

BOX 5. JVL: A key partner for resource recovery and reuse.

JVL is a limited liability company (100% Ghanaian ownership) established in 2003 and registered to operate as a waste management company. JVL provides:

- Solid waste collection services: JVL holds the Accra Metropolitan Assembly (AMA) Franchise Agreement, under its Fee and Performance-Based Solid Waste Collection Service to collect all solid waste generated within the Osu Klottey Sub-metropolitan area and dispose of such waste at treatment and final disposal sites designated by the AMA. JVL also has a similar franchise operation on a smaller scale in the Adentan Municipal Assembly.
- Public toilet management: JVL manages a modern water closet public toilet facility at Teshie-Accra under a franchise service agreement with Safi Sana Ghana Ltd., a Dutch NGO. A second public toilet facility, also located in Teshie-Accra, but built from JVL resources is also functioning. JVL also manages a modern water closet public toilet facility at Teshie-Accra under a franchise service agreement with Safi Sana Ghana Ltd., a Dutch NGO.
- Compost production: JVL started a pilot project in 2013 looking at an integrated approach to delivering cost-effective waste management services. Under this project, JVL manages a mini compost plant (the Ga-mashie Aerobic Composting Facility), built with support from CHF International and located in the Ashiedu Keteke Sub-metro area of the AMA. JVL also manages the plant built under the IWMI-supported WaFo project in Tema.
- Consultancy services in the waste management sector.

JVL has approximately 50 full-time employees with a solid waste collection capacity of 8,000 tonnes per month.

Sources: IWMI 2014; Annan, M. 2021 (personal communication).

3.4 Sourcing Waste

Regular access to sufficient quantities of waste is a key determining factor of any reuse business. This is why establishing production facilities at strategic locations to which waste can be easily transported is important for the viability of the business. CapVal conducted a number of feasibility studies on feedstock assessments. These studies assessed each potential feedstock in terms of source, quantity, quality, current use, supply

limitations and potential risk. Studies concluded that the most appropriate local feedstock for composting was organic waste from markets, mango waste from surrounding farms, in addition to fecal sludge from private and public toilets from the surrounding districts. In addition to YKMA, there are five other districts from where vacuum tanker operators convey fecal sludge. The facility works with four out of the five vacuum tanker operators in the Assembly.

However, the supply of organic waste was identified as a potential risk. Collection of organic waste from the market was identified as a risk because disruption is likely to affect feedstock supply to the plant. The selected market for sourcing organic waste is one of the large trading hubs within close proximity to the plant. However, it is located within a municipal assembly (Lower Manya Krobo, LMKMA) outside the jurisdiction of the YKMA where the plant is located. The situation presented a risk that could prevent sourcing large quantities of organic waste at one site and at low cost to the plant.

To mitigate and reduce the risk, an agreement was signed between the two municipalities. There is an agreement that provides incentives to LMKMA and clarifies parties' responsibilities. According to the agreement:

- LMKMA should enable access to its market for waste collection and appoint laborers to assist with waste collection;
- YKMA is to provide tools and equipment for waste collection; and
- YKMA shall provide performance-based financial incentives to laborers in consultation with LMKMA.

In addition to the agreement, sourcing waste requires engagement with communities and market women in particular. Indeed, once waste is valued as a source of goods, it ceases to be perceived as a nuisance by parties, but rather as a valuable product, i.e. with market value. This can pose a problem for sourcing waste at no cost – a model on which the CapVal model was built. Engagement with market sellers was essential to ensure waste was provided in sufficient quantity at no cost.

3.5 Capacity Development

The establishment of re-use businesses requires private and public capacity development.

For the private sector, CapVal trained local staff to enhance their knowledge on reuse practices and enable them to undertake activities at the plant. IWMI and partners conducted training for the composting, briquette and aquaculture plants. Seventeen staff members were trained on fecal sludge and municipal organic solid waste composting from September 2020 to January 2021. The training sessions included COVID-19 safety protocols, risk assessment and mitigation, feedstock sourcing and pretreatment, composting and compost process monitoring. Eight staff members were trained on biomass waste briquetting from September 2020 to January 2021. Ten people including three master degree students were trained every year from 2017 to 2019 on the fish production system. Plant staff were trained on safe fish production practices, maintenance and office management.

For the public sector, municipal waste management departments also benefited from training on the reuse process and cost recovery mechanism for liquid and solid waste management. In addition to technical knowledge, CapVal contributed to increasing capacity of the public sector for partnering the private sector. The project delivered a model contract (the JV), which can be replicated. Throughout the project, discussions with YKMA and KMA were necessary to highlight their roles in the JV.

Once the plant is fully functional with significant production, IWMI and partners are planning to increase efforts to share knowledge of the composts and the briquettes with all neighboring stakeholders. For the compost market, training for the district agriculture and extension officers, greenhouse producers, mango

farmers and vegetable farmers on compost use in the field is planned. As for briquetting, demonstrations of the use of briquettes to targeted communities/institutions are being planned as well.

3.6 Market Adoption

CapVal has been instrumental in developing business models and identifying marketing approaches especially for compost and briquettes, which are 'new' products to be launched in the markets. Project partners received extensive support in the form of market research, insights from which helped to inform business models and approaches to market development and customer outreach.

With regard to composting, CapVal carried out multiple studies to identify sources of waste supply and to design strategic engagement with the different market segments to secure sales contracts for the plant. Preliminary studies assessed the knowledge and usage of various types of farmers involved with the compost product. Potential off-takers were shown to be primarily greenhouse farmers – the most significant compost users – followed by mango seedling producers and vegetable farmers. Mango farmers were identified as the least promising market segment to use compost due to their overreliance on inorganic fertilizer. Farmers generally showed their willingness to use compost but required field demonstrations to show its effectiveness.

Similarly, CapVal introduced valuable knowledge on briquette market adoption in Ghana. Studies were carried out on market segments for briquette production and sales. Studies highlighted alternative products currently in use (mainly wood and residual fuel oil) and three main market segments: the export, industrial and local retail markets with the immediate target market for sales identified as the industrial market. The project also supported engagement with potential off-takers.

4 WHAT ARE THE OUTCOMES?

Projects such as CapVal have significant socioeconomic and environmental impact potentials. This section highlights the intended impacts of the project and some of the results achieved on these fronts, where data are available.

4.1 Sanitation Services

CapVal has had clear impacts on the provision of sanitation services, albeit at a small scale, in the two localities where businesses were established. However, hard data on the impact of the plant on the provision of basic sanitation services are limited.

In Somanya, where the compost and briquette plants have been installed, key facts demonstrate the outcomes of CapVal on sanitation services:

- Yilo-Krobo and surrounding municipalities did not have a properly engineered treatment and disposal facility for fecal sludge prior to the project. Following completion of the project, vacuum truck operators are using the facility, which means less fecal sludge is dumped untreated in the nearby environment;
- According to feasibility studies, YKMA produces about 3,000 m^3 of fecal sludge per year while the five other surrounding municipalities produce about 54,308 m^3. The plant capacity of potentially up to 5,000 m^3 per year means that it may be able to cater for waste generated in YKMA and also accept some volume from surrounding municipalities. However, the ability to receive the volumes provided

in a day or a week depends on the drying process – which depends on weather conditions and the type of fecal sludge – and whether drying beds are available to receive fecal sludge;

- Prior to the project, all solid waste produced in YKMA was disposed of at open dumps in adjoining municipalities; a small fraction of this organic solid waste can be redirected to the Somanya plant; and
- As of January 2021, the Somanya plant had processed 114 tonnes of food waste; 255 m^3 of fecal sludge and produced 20 tonnes of compost.

Similarly, there has been a positive outcome on sanitation services in Kumasi, although there are no precise data of how the WWTP was managed before the JV with TriMark. Accounts of the situation of the WWTP at the start of the project indicate inadequate management, with a negative impact on the environment and the quality of life of neighboring residents. The management of wastewater for aquaculture purposes, therefore, most likely enhanced treatment levels significantly and contributed to mitigating any environmental degradation due to untreated waste. The quality of effluents from the facility has greatly improved.

Overall, the CapVal project demonstrates that including reuse at the end of the sanitation value chain improves treatment processes, **especially where the private sector is involved.** Indeed, although reuse is dependent on the availability of waste feed, and therefore the sanitation service chain, it is a stand-alone business, requiring its own skills and incentives. As such, reuse businesses appear best led by the private sector which can deploy the expertise required in view of potential financial gains.

The nature of the contract with the private sector is a determinant for ensuring adequate treatments. Although it is early days to assess the contracts and their implementation, the JV agreements introduced in CapVal appear to provide the right balance in terms of risks shifted to the private sector and incentives to perform. On the one hand, they allocate financial responsibilities to the private sector as it is in charge of O&M of the treatment facilities; on the other hand they limit this financial exposure by allocating the bulk of capital investments to the public sector side. At the same time, both parties jointly own existing assets, securing private sector operations in the medium term (15 to 20 years). Finally, performance indicators for treatment standards and by-product quality mitigate risks from cost-saving measures undertaken by the private operator that affect performance. The establishment of a management structure with performance indicators (as set in the contract) is an important step towards waste management.

4.2 Ecosystem Protection and Climate Change Action

While it is too early to talk about the project impact on ecosystems, CapVal is demonstrating business models that contribute to their protection. Quality waste treatment, and therefore ecosystem protection, are at the heart of the three businesses the project has established. On the one hand, the existence of the two facilities that have been constructed under the project enable waste generated to be dumped at a designated site. Further, the quality of by-product production is indeed dependent on the quality of waste treatment. This is the case not only for fish culture, but also for composting and briquetting. As discussed in Section 3, at the WWTP in Kumasi, water treatment quality was enhanced by adding biodigesters to boost the safety of fish production.

By-products generated directly contribute to ecosystem protection and restoration and to climate change mitigation. The compost produced is an alternative or a complement to chemical fertilizers used by farmers, which could pollute soils and water resources. It could therefore become a central component of nature-positive production and farming. If adopted at scale, the municipal solid waste-based compost could help to restore degraded ecosystems by positively affecting the physical, chemical and biological characteristics of the soil, thereby enhancing resilience to climate variability. Reduction of greenhouse gases associated with the improved waste management could help mitigate climate change by reducing greenhouse gas emissions.

The briquette business demonstrates how energy can be recovered from wood and crop residues contributing to reducing this type of organic waste and associated pollution. This alternative source of energy reduces dependence on wood for energy hence reducing deforestation and land degradation and mitigating climate change impacts.

The Akorley and Somanya areas have high dependence on wood and charcoal and this carbonaceous compound has a significant negative impact on forest resources and community health. Thus, in addition to improvement in environmental sanitation, the briquetting plant will increase access of households to clean energy with long-term positive impacts on forest resources.

4.3 Job Creation, Gender Equity and Livelihoods

Reuse businesses contribute to job creation and improved livelihoods, especially for communities surrounding treatment and re-use facilities. In total, the Somanya plant employs 17 staff, four of whom are women. Most belong to local communities in YKMA. Women also occupy management and decision-making positions. In Kumasi all the eight members of staff belong to communities in KMA and surrounding municipalities. However, there is no example of what other businesses with the same investment could have achieved for comparison.

Anticipated livelihood opportunities are both direct (for staff) and indirect (for waste generators and for users of the products (the latter is yet to be confirmed on the ground)). These opportunities provide economic empowerment for low-skilled staff who may also have found it difficult to obtain other employment opportunities in other sectors. The selection of staff members from members of the community also provides some stability and sustainability when it comes to retaining them as they live nearby.

5 BRINGING THE LESSONS LEARNED TOGETHER

This section brings together lessons learned from the design and implementation of the CapVal project. The lessons learned inform strategies related to sanitation, agriculture and the energy sectors and for the design of future resource recovery and re-use initiatives and businesses.

5.1 Private Sector Participation

The private sector has an important role to play in waste resource recovery and reuse. Experience from CapVal shows that some companies and entrepreneurs have appetite for risks related to waste valorization. There is a particular incentive for those already working on solid waste management and fecal sludge emptying as the FSTP also provides a safe treatment and disposal facility. However, there is a need for contracts that balance risks taken by both parties – the JV, whereby both parties co-own assets, provides an innovative way to reduce risks perceived by the private sector.

In the short term, SMEs are likely to be best placed to take on the risks involved in the waste resource recovery business. Larger companies with higher financial capacities may not be interested in investing in waste management due to limited potentials for revenue generation. However, SMEs also face constraints related to working capital and should be supported in accessing finance or by lifting barriers to entry through tax waivers, for example.

Private sector participation in the management of waste treatment plants enhances treatment processes and standards. WWTPs can be turned into grounds for attractive businesses that can enhance the treatment process and plant maintenance. TriMark is clearly on the path to becoming a thriving business, although most investments are still coming from donors and research centers.

Project partners should therefore be carefully selected to ensure they can fulfil their roles. CapVal experienced multiple setbacks, with two private companies pulling out. However, achievements were enabled by the commitment of existing partners, particularly JVL and YKMA. This commitment helps to ensure their engagement for overcoming challenges that arise. YKMA played a critical role for securing land and engaging with neighboring municipalities on waste collection. JVL showed flexibility as the company was able to adapt to changing circumstances and challenges.

5.2 Profitability of Waste Resource Recovery Businesses of the three businesses

CapVal has supported, the compost business faces the most challenges and risks to financial viability. These risks mainly relate to tough competition from other fertilizer suppliers that can offer higher volumes of products at a lower price. The government subsidy policy which disadvantages small-scale fertilizer producers (see Section 2) and the lack of familiarity of potential customers with compost are other drawbacks. These findings are in line with international experience, which indicates that composting, on its own, may not be sufficiently attractive financially without public funding support, including for operational expenditures. Improving revenues requires more efficient design of the facility, by shifting from manual to mechanical processes for turning the compost and allocating staff members only for collecting and sorting in addition to management and sales (i.e. no outsourcing for these duties). This upgrade in the process will increase productivity, but requires some additional investment. Discussions with the private partner (JVL) indicated that producing at a much larger scale could help increase profitability.

The project demonstrates the potential to harness reuse as a revenue source for MMDAs. Sanitation and management of waste are generally perceived as a major cost for which there is often inadequate funding; however, CapVal has shown that MMDAs can shift this perception, provided they can also allocate funds for capital investment (with or without external support, including from the central government). CapVal shows how MMDAs could partner with the private sector through such a PPP mechanism to raise funds for investment in sanitation, manage the facilities cost-efficiently and use the sales for reuse products as a revenue source.

5.3 Roles of Public Donors and Actors

Funding for capital investment and institutional support. CapVal was made possible by the allocation of public funds for capital investment and institutional support, including capacity development, business development support and regulation compliance. This initial investment and packaging of support were critical for mobilizing additional resources, including from local governments and the private sector – in the form of working capital. Revenues generated to date indicate that waste resource recovery businesses will continue to require this initial public support in order to take off.

Public funds beyond capital investments. CapVal also indicates that public funds for waste resource recovery business support are likely to be required at least up until early stages of business operations. Indeed, at early stages, businesses are still testing and calibrating production and engaging with potential customers, with little to no revenue generated over a substantial period of time. Both the briquette and composting businesses supported by CapVal could not break even for at least 3 years into operations. Considering the environmental and socioeconomic benefits these businesses can generate, there is a rationale for extending public funding

support into these initial years of operations, mainly for assisting with business development and providing research insights.

Taking on some risks related to waste-to-recovery businesses. The project was made possible by the capital provided by public funds, which allowed experimentation and risk taking. At the start of the project, one of the greatest risks was land availability. CapVal had to change location several times due to the issue, which delayed implementation – and required additional resources for feasibility studies. Despite the initial set-back, the project successfully helped to establish the composting and briquette facilities. Without the public funding the project received, this achievement would not have been possible.

Providing subsidies and advocating for organic fertilizers. A key policy take-away is the need to specifically subsidize organic compost and to increase awareness of its benefits among farmers to boost the uptake of this alternative product. As of 2021, the fertilizer subsidy program in Ghana targeted both organic and inorganic fertilizer producers; however, small-scale producers such as JVL were excluded from the subsidy program due to the limited size of their productions. The subsidy policy should be revised to enable such small-scale producers to compete with larger producers. Finally, information dissemination on the benefits of organic fertilizers should be led by government agencies, rather than leaving it to producers alone.

Making land available. Land availability is a challenge for scaling up waste treatment and transformation. Project implementation was hindered by lack of land. If Ghana – and other countries – are to tackle the challenge of waste management, land needs to be allocated for this purpose. Land allocation should be included in the planning for waste management both at the municipality and national levels. Allocation of land for waste management must be prioritized in the development of spatial plans by the land use and spatial planning authority. Furthermore, lands that have been located for waste management must be secured and protected. This may require allocating funds to acquire and register it officially before competent authories to protect ownership, and to obtain the required permits.

5.4 Roles for Research and Civil Society Organizations

Knowledge generation, transfer and capacity development. A key role for research institutes and CSOs, if such initiatives are to be replicated, is to generate data that inform development of the products, and build knowledge and capacity of private and public actors. For example, development of compost and fuel briquettes has involved research on the production processes and resulting quality. For many stakeholders involved in the project, sanitation and waste valorization are new business lines; approaches CapVal put forward, especially the PPP model, are innovative for local governments and the sanitation sector**.** Knowledge transfer on the potential of waste valorization and how to engage with the private sector are therefore critical components of the project.

Developing institutions' capacity to fulfil their responsibilities – via staff training but also contract design and negotiation – is another key consideration for replicating such initiatives. MMDAs in particular require particular support and capacity development regarding their role in waste management. CapVal also demonstrates the need to build consensus and agreement between parties to ensure the smooth operations of facilities and businesses. In the case of the composting business, an agreement was required between two different municipalities on the supply of waste. The agreement also entailed a package of incentives to the partner municipality to ensure adequate resources and commitments

Such institutional support is required from project start up until the first years of business operations to address unforeseen events and potential setbacks.

Market research. Market research led by IWMI provided intelligence and insights into customer preferences and the nature of the market within which businesses are competing. Taking on the costs of this market

research and channelling business development support based on market insights (for the preparation of business plans in particular) provide additional incentives for private sector actors to invest their own resources in such initiatives. The involvement of specialized research institutes such as IWMI can help off-take some early stage risks and provide some level of confidence on the quality and reliability of market research.

Encouraging policy uptake. As waste valorization initiatives remain at a very early development stage, particularly in Ghana, there are significant opportunities for research institutions and CSOs to influence relevant policies and regulations. For such projects to be replicated, national government institutions have an important role to play for such projects to be replicated, including for:

- Disseminating knowledge on the PPP model and the JV-type contract: many municipalities in Ghana are not aware of the potential of such contracts and lack the tools to implement them (from procurement mechanisms to draft contract and partner evaluation);
- Supporting the preparation of municipal plans for sanitation that clearly identify suitable land and budget for acquisition and preparation; and
- Assisting partnerships among municipalities for larger facilities and steady supply of waste.

Approaches put forward in CapVal, institutional tools developed under the project and results achieved to date should be disseminated to national actors with the active participation of private and public actors that have contributed to the project success.

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ANNEX 1: LIST OF PEOPLE CONSULTED

	Name	Organization/position	Role in project
1	Hon. Ebenezer Tetteh, Kupualor	Municipal Chief Executive, Yilo Krobo Municipal Assembly – (YKMA)	MMDA partner
2	Yvette Kwami	Admin Officer (YKMA)	MMDA partner
3	Dzifa Agbefu	Plant Manager at Jekora Compost Facility in YKMA	Private sector operator
4	Mark Agyepong Yeboah	CEO, TriMark Ventures	Private sector operator
5	Ossei Assibey Bonsu	Public Health Engineer, Deputy Head, Waste Management Department, Kumasi Metropolitan Assembly (KMA)	MMDA partner
6	Benedict Tuffuor	Managing Consultant, TREND	Setting up partnership and certification; stakeholder engagement
7	Ransford Kojo Mensah	Project Officer, TREND	Setting up partnership and certification; stakeholder engagement
8	Josiane Nikiema	IWMI	Research partner
9	Eric Nartey	IWMI	Research partner
10	Solomie Gebrezgabher	IWMI	Research partner
11	Patrick Apoya	Independent catfish producer	Stakeholder/expert