BUSINESS MODEL 24

Farmers' innovation capacity as driver of change

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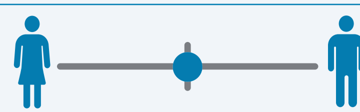
Model name	Farmers' innovation capacity as driver of change
Waste stream	Domestic grey water, wastewater-polluted stream water
Value offer	Partially treated wastewater for crop irrigation
Geography	Suburban low/wetlands used by farmers
Scale of business	Small scale (community)
Location of supporting cases	This model is in its presentation a hybrid of case and model and builds on observation in particular in Southern Ghana
Objective of entity	Social/Environmental enterprise [X]
Investment cost range	USD 15,000–25,000
Organization type	Community based organization
Major partners in the case example	Farmer association, Friends of Ramsar Site (NGO), Environmental Protection Agency, Wildlife Division of Forestry Commission, local assemblies, UNEP, Ministry of Food and Agriculture (MoFA)
Socio-economic impact	Fresh food for urban households. Every USD invested in on-farm treatment and post-harvest safety returns up to USD 4.9 in public health cost savings
Gender equity	**Generally balanced, but gender roles vary along value chain** 

Executive summary

This business model has been informed by observations from wastewater using farming communities in India and West Africa where farmers show a significant innovative spirit to adapt either to declining water quality (Buechler and Mekala, 2005) or challenges in accessing water (IWMI, 2008a). The here presented model is based on a distinct example from Ghana and follows in its presentation a **hybrid of the business model and case templates**.

This example derives from Ghana's coastal region where farmers struggle with poor water quality and their irrigation infrastructure supports natural water remediation processes. Although risk reduction is not the main driver, the system supports the public interest in water (food) safety and forms a first step transition from informal to formal wastewater use. The farming site is located between several smaller, essentially temporary streams, which feed into the Sakumo lagoon in the densely populated

Accra-Tema mega-polis of Southern Ghana. There is very limited sewerage and wastewater treatment in this suburb and the streams carry highly polluted water from a wider urban catchment area, generated by households, trade and small industry. Since 1992, the 1360 ha wetland area around the lagoon is protected under the Ramsar convention[1]. About 414 ha of the land are used for irrigating traditional vegetables, with increasing shares of rainfed maize in the rainy season. The informal irrigation system as designed by the farmers combines gravity flow (also by blocking streams), canals or PVC pipes, and smaller storage ponds (dugouts), as well as portable water pumps. The system is designed to reduce the burden of carrying water over longer distances. Based on farmers' original efforts of creating storage facilities, the local community based NGO Friends of Ramsar Site (FORS) suggested in 2011 to upgrade the created canals and ponds into a designed natural treatment system. Farmers invested labor and cash to the tune of USD 3,600 while FORS secured from UNEP an additional amount of about USD 13,200 to upgrade the system with four smaller constructed wetland lagoons. Currently, more than 200 farmers are settled around the site, supported by a much larger number of seasonal labor. It is estimated that farmers generate a gross revenue of about USD 200,000 annually from the production of crops on the overall site with a high benefit-cost ratio[2]. As only a section (max. 30%) of the farmers was able to connect to the treatment system, FORS plans its extension. This has, however, to be accompanied with awareness creation on health risks, for farmers and consumers, to create more market demand for safer produce as further incentive for the farmers to engage in the innovation. In 2014, due to severe flooding and damage of infrastructure, the system stopped functioning and was still not operational again early 2017.

KEY PERFORMANCE INDICATORS OF THE CASE IN GHANA (2014)						
Land use:	414 hectares (1022 acres) of irrigated land of which about 30% were connected to the treatment system in 2012/13					
Water treated:	0.6–1.2 million cubicmeter (MCM) per year assuming 1–2 60-day cropping cycles					
Capital investment:	Ca. USD 16,800					
Labor requirements:	12–20 people needed for dredging (dredging done 2–3 times a month)					
O&M:	Up to USD 1,200 per season distributed over the local farmer association					
Output:	Partially treated wastewater for irrigation and in part livestock watering					
Potential social and/ or environmental impact:	With the planned extension up to 200 crop farmers (80–90% men) and an estimated 400 seasonal laborers (60% women) could benefit from access to partially treated water. The production of safer food benefits consumers in Tema and Accra, especially for food items eaten uncooked, and the overall site which as a traditional as well as tourist value					
Viability indicators:	Payback period:	N.A.	Post-tax IRR:	N.A.	Gross margin:	N.A.

Context and background

Due to limited wastewater collection and treatment, urban streams are across sub-Saharan Africa heavily polluted and mostly conveying domestic greywater, solid waste but also overflow from septic tanks, pushing especially pathogenic water quality indicators far above acceptable levels. The poor water quality is an increasing burden for farmers who depend on irrigation, as well as the environment as also shown on the example of the Sakumo Lagoon (Asmah et al., 2008; Agbemehia, 2014) near Accra. This wetland of international importance, which was declared in 1992 as a Ramsar site[3], covers an area of about 1,360 hectares and is situated between Ghana's capital city and Tema in the Greater Accra Region of Ghana. The size of the open lagoon varies between 100 and 350 hectares depending on the season. Four sub-basins are supporting the freshwater supply of the site: the major ones, named after their streams, are the Mamahuma and Onukpa Wahe (at the western side) and the

Dzorwulu and Gbagbla-(An)konu (situated at the northern end). The Eastern and Southern subbasins constitute minor inflows. The main feeder streams, the Dzorwulu and Mamahuma have been dammed upstream of the Ramsar site and re-channeled for local irrigation, such as the Dzorwulu stream which supports the well-known Ashaiman reservoir and irrigation scheme. The damming has resulted in very little influx of freshwater, that especially during the dry season wastewater dominates the flow. The streams are draining a wide urban catchment area capturing mostly domestic wastewater and storm water, but also effluents from lighter industry.

Ramsar administrative authority in Ghana is the Wildlife Division of the Forestry Commission. Farming and fishing are permitted and date back as long as farmers can recall. In 2010, the local farmer association '*Resource Users Association'* invested major efforts in improving water access, especially in the dry season, including a larger storage pond which can be connected to several farms. Farmers contributed labor and USD 3,600 in cash. In a subsequent development, the Friends of Ramsar Site (FORS), a non-profit organization, mobilized about USD 13,200 from UNEP to upgrade the treatment potential of the canals and pond system the farmers put in place via constructed wetlands (lagoons). The potential for high synergies between infrastructure in farmers' interests and natural pathogen elimination have been described for other sites in Accra by IWMI (2008a,b) and by Keraita et al. (2014), which offers a possible pathway in support of a gradual transition towards safer wastewater irrigation as supported by WHO (2006).

There are about 600 ha under farming of which around 414 ha are irrigated by at least 200 farmers supported by about 400 seasonal laborers. The major crops grown include fresh vegetables such as cucumber and green pepper, local vegetables (like okra, pepper, onion, tomatoes, ayoyo) and maize that are all in high demand in Accra. About 30% of the farmers were so far connected to the natural treatment system while the majority continues using untreated wastewater, but there are plans by FORS to increase the number of users by expanding the treatment system. The type of water used by farmers still depends mostly on convenience and pumping costs, not on risk awareness. Urban farmers are generally more concerned with visible trash (e.g. plastic) in the water while missing knowledge of invisible contaminants (Keraita et al., 2008). However, farmers at Sakumo indicated that the appearance and bad smell sometimes emanating from the wastewater is a challenge to them that they stopped irrigating a few days before harvest[4]. Sensory attributes such as the crop appearance, neatness and size rather than possible invisible health risks are also common among traders and consumers and reflect the common educational status (Keraita and Drechsel, 2015).

The Sakumo area received annually about 800 mm rain and has high educational (e.g. bird watching) and recreational value, being one of the few 'green' areas left in the rapidly expanding Accra-Tema metropolitan area. The lagoon is moreover regarded as a fetish by the local people and the local Black Heron bird is considered sacred.

Macro-economic environment

With an upsurge of both wastewater generation and irrigated urban farming, options which can increase produce and farmers' safety are needed across sub-Saharan Africa.

Urbanization and the growing urban demand for food are driving year-round food production which requires irrigation in the dry season(s). While some crops can be produced in irrigation schemes in rural areas and with safe freshwater, other crops are easily perishable and urban proximity is favored due to the lack of cold transport and storage but also as shorter food chains give financial advantages. However, urban proximity has also disadvantages. As at least 80% of the wastewater generated in Ghana's urban centers is released into the environment in its untreated form, making it nearly impossible for farmers to find any unpolluted water source (Drechsel and Keraita, 2014). Groundwater access could be one option but seldom in ocean vicinity and also not at Sakumo (Agyepong, 1999). In Ghana, there are no data to tell where along natural streams contamination levels exceed irrigation thresholds. Without ability to monitor water quality or offer farmers a viable alternative, irrigated urban farming with its obvious benefits but also health risks remains in a state of "laissez-faire" without enforced restrictions or serious assistance (Drechsel et al., 2006; Drechsel and Keraita, 2014). The national irrigation policy (MoFA, 2011) permits safe wastewater use in line with the 2006 edition of the WHO-FAO-UNEP water reuse guidelines which demand for situations without treatment plant alternative risk barriers from 'farm to fork' (Amoah et al., 2011). The importance of urban farming in this context should not be underestimated: Lydecker and Drechsel (2010) estimated that in Accra more wastewater is 'treated' on-farm than in designated treatment plants.

Business model

The business is run by the Resource Users Association, a commercial farmers group producing crops for the local market. The value proposition of their and FORS co-investment is improved water access combined with reduced health risk despite the use of polluted irrigation water (Figure 273). Although the initial main driver of this business model was to access water for irrigation all year around, the private sector-NGO partnership added the safety objective.

The drive to get access to water has catalyzed farmers to invest jointly in the pond and canal system, a system which supports natural water remediation processes and can easily be combined with further safety enhancing features (cf. IWMI, 2008a,b; Keraita et al., 2014). The partnership with FORS created a win-win situation whereby the irrigation water receives a pre-treatment, farmers who like to join the association get access to water also in the dry season, and consumers are a step closer to safer food. The farmer association can be considered as owners of the wastewater treatment system as they invested both cash and labor for the construction of the system and are paying for its O&M costs. The farmers' association is now registered in the registrar general and has a constitution which explains the responsibilities of each member with regards to the wastewater treatment system[5]. The cost to maintain the system are borne by farmers as the situation arises, i.e. they don't pay regular fees for using the water but when there is a need, farmers are required to contribute. This is the case after seasonal flooding when the self-made dams blocking the river are commonly destroyed. If the farmer fails to contribute, the association will give a warning to the farmer to make the payment.

Normally, farmers understand that if the system does not work, they will not be able to get water. But in instances where a farmer fails to contribute to the maintenance of the system, the association can seize the farmer's water pump.

Value chain and position

The Ramsar wetland is used for different productive uses such as for crop farming, livestock rearing and fishing (Figure 274). Initially farmers had no alternative to using highly polluted stream water. An alternative option was created by the Resource Users Association and FORS which enabled farmers to use partially treated wastewater, and the lagoon to receive less floating debris. Although so far not all farmers at the Ramsar site can connect to the treated wastewater and traders still receive crops produced with untreated water, there are plans by FORS to increase the number of users by expanding the treatment system.

FIGURE 273. BUSINESS MODEL CANVAS – FARMERS' INNOVATION AS DRIVER OF CHANGE

KEY PARTNERS

- Friends of Ramsar Site (FORS)
- Environmental Protection Agency (EPA)
- Wildlife division
- UNEP
- Ministry of Food and Agriculture (MoFA)
- Local community of Sakumono
- Research partner or technical advisor

KEY ACTIVITIES

- Installing and maintaining a water storage cum treatment facility
- Advocacy by FORS
- Ensuring that farmers adhere to rules stipulated in the farmer's association's constitution

KEY RESOURCES

- Diluted wastewater
- Technical expertise
- Constructed wetland
- Macrophytes for natural water treatment
- Financing, labor

VALUE PROPOSITIONS

- Year-round access to safer water for irrigation than so far available

CUSTOMER RELATIONSHIPS

- Formal relationship between farmers and the farmer association
- Personal relationships with crop buyers (traders), indirect with consumers

CHANNELS

- Direct use of wastewater by farmers
- Depending on crop direct marketing or on-farm sale of produce

CUSTOMER SEGMENTS

- Farmers cultivating irrigated crops
- Public/authorities calling for safe produce
- Crop traders

COST STRUCTURE

- Capital investment by the Resource Users Association
- Capital investment by FORS
- Operation & Maintenance cost by farmers

REVENUE STREAMS

- Cash and in kind contribution by farmers for system set up and O&M; no payment for water from streams which is free in Ghana

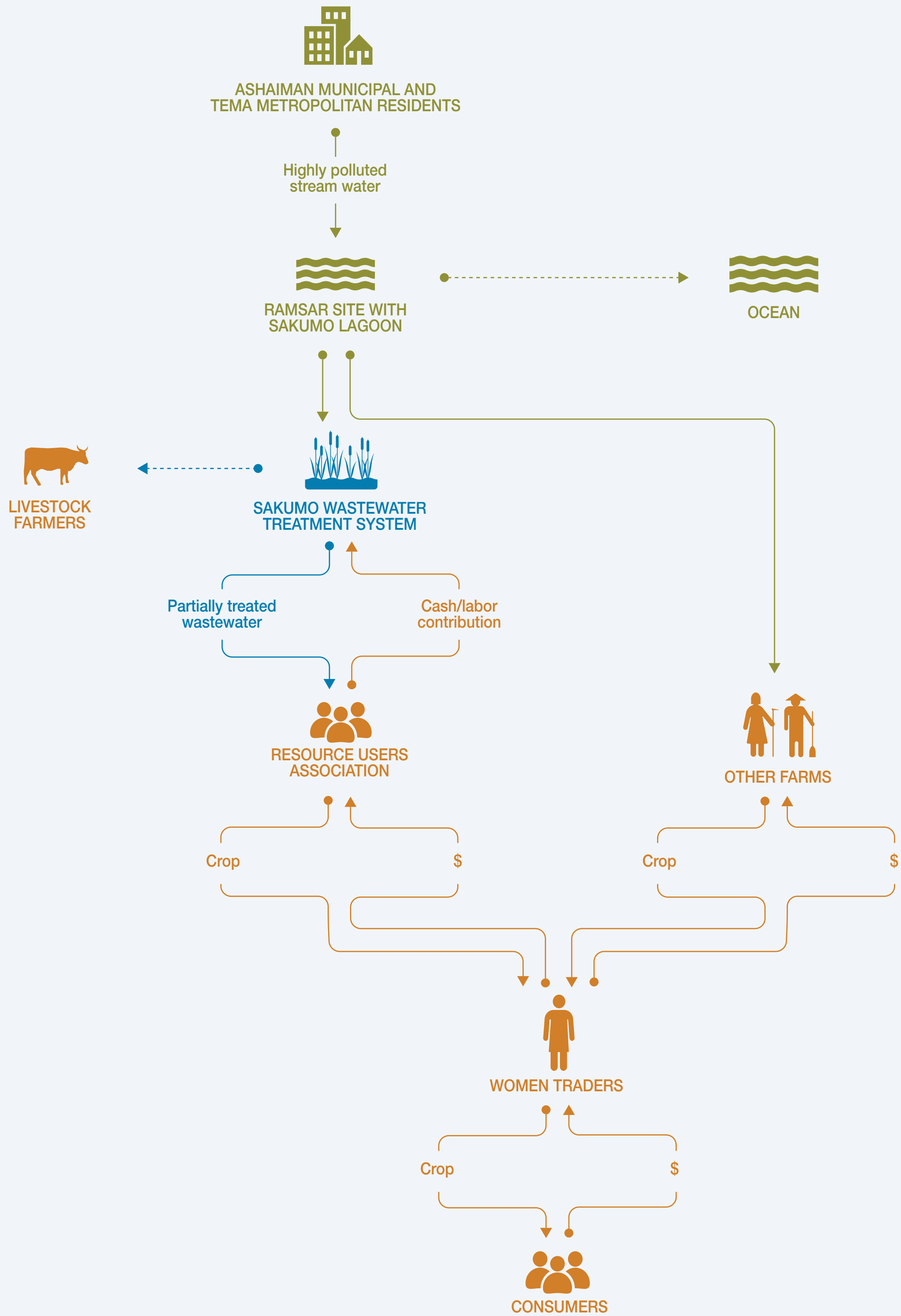
SOCIAL & ENVIRONMENTAL COSTS

- Possible increase in mosquito bites due to constructed wetlands (but as the whole area is a wetland, the added risk is marginal)

SOCIAL & ENVIRONMENTAL BENEFITS

- Compared with 'no intervention' possible risks to farmers, soils, crops and consumers will be reduced, but not eliminated
- Enhanced food security, possibility of connecting more farmers
- Partial removal of plastic waste which will benefit tourists and the local community around the main Lagoon

FIGURE 274. BUSINESS PROCESS FLOW AT THE SAKUMO FARMING SITE NEAR TEMA



Institutional environment

A set of policies and development plans provides the legal context for the institutional arrangements at the Sakumo Ramsar site near the community of Sakumono. The Ramsar site was created in 1992 by the legislative instrument (LI) 1659 and classified as an environmentally sensitive area under the Ghana Environmental Assessment (EA) regulation, legislative instrument (LI) 1652 of 1999. The National Land Policy of 1999 allows for the agricultural cultivation of wetlands provided its productivity is sustained. The Ministry of Local Government and Rural Development under the Ghana National Urban Policy Action Plan of 2012 recommends the development and use of open spaces, green belts and ecologically sensitive areas for urban farming. The common use of 'wastewater' in this context has been acknowledged in Ghana's National Irrigation Policy, Strategies and Regulatory Measures which recognized the relevance of the informal irrigation sector, and recommends compliance with the WHO (2006) wastewater use guidelines. Guidelines for the protection of the wetland are given in Ghana's National Wetlands Conservation Strategy and Action Plan (2007–2016).

The various institutions involved at the site and their roles include:

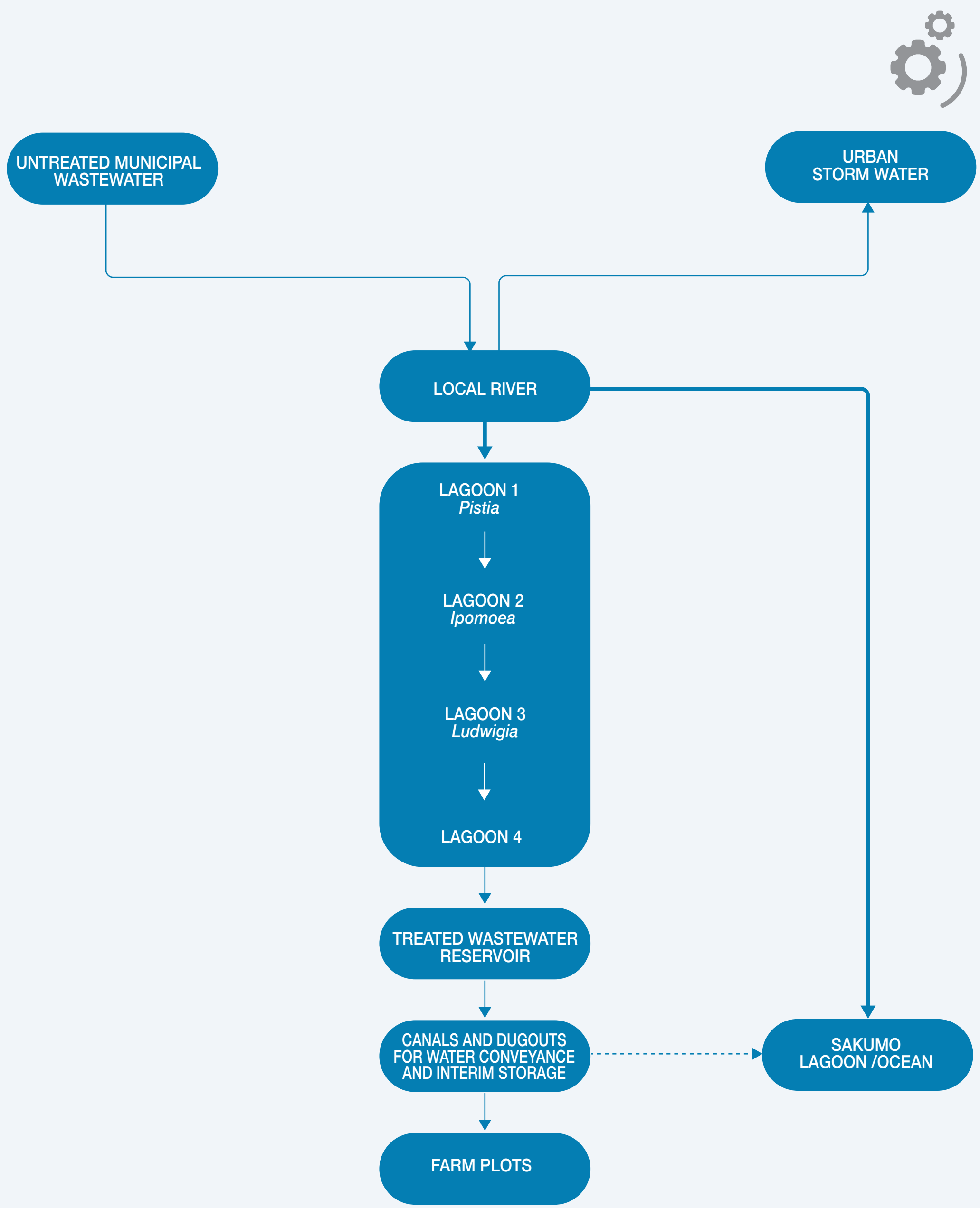
- *The Wildlife Division of the Forestry Commission under the Ministry of Land Forestry and Natural Resources* – responsible for the management of the Ramsar site, and helps to resolve conflicts between resident and seasonal farmers.
- *The Environmental Protection Agency* – responsible for monitoring and preventing of the pollution from the surrounding areas also as the Ramsar site is officially an environmentally sensitive area[6].
- *Tema Metropolitan Assembly* – is the city authority responsible for enforcing laws/bylaws and legislations concerning the site.
- *The Ministry of Food and Agriculture* – provides extension services to the farmers to guide and provide advice on agricultural input use and farming practices.
- *Resource Users Association* – a farmer association which had in 2014 about 75 members (13% women) use partially treated wastewater for irrigation at the site and which contributed in the construction and maintenance of the treatment system[7].
- *Friends of Ramsar Site* (FORS) – a non-governmental organization and advocacy group that helped to construct the wastewater treatment system, is responsible for its management and actively lobbies for the protection of the Sakumo site.
- *UNEP* – co-funded the construction of the wastewater treatment system and local tree planting[8].
- The surrounding communities such as Klagon, Sakumono, Community 3 and 19, and Nungua; their assemblies and traditional chiefs.

The local NGO FORS plays in this case a prominent role as broker between the different parties. However, for any replication of the case, FORS represents only one of many opportunities of local communities to engage and support their wetland and open farming areas in an urbanizing environment based on their various direct and indirect benefits (see also Lydecker and Drechsel, 2010).

Technology and processes

The water treatment at the Ramsar site (Figure 275) is based on natural processes (pathogen die-off, sedimentation, nutrient uptake, physical barriers, ...) where stream water is temporarily blocked and redirected through channels to four treatment ponds (100m^2 lagoons). The macrophytes *Pistia* (water lettuce), *Ipomoea* (water spinach) and *Ludwigia* (water primrose) are growing in the first three lagoons respectively while the fourth lagoon exposes the polluted water to sunlight. Eventually the water flows into a reservoir from where it is pumped onto the farms while excess water flows through a canal into the Sakumo lagoon and then into the sea. From time to time, the macrophytes are harvested and composted to fertilize the soil.

FIGURE 275. TREATMENT PROCESS DESIGN FOR WASTEWATER REUSE IN SAKUMO RAMSAR SITE NEAR TEMA, GHANA



First laboratory data showed that the system could be improved (retention time etc.) to increase the treatment quality. On another site in Accra at La, a farmer based cascade of small reservoirs showed a positive impact on pathogen levels (IWMI, 2008a). FORS is actively seeking collaboration with research institutions to optimize the system.

There are other examples, e.g. from India, showing how typical irrigation infrastructure can support water treatment processes, in particular the removal of pathogens (Ensink et al., 2010).

Funding and financial outlook

The generated capital investment for the wastewater treatment system was about USD 16,800, contributed by farmers and FORS. The investment took place in three phases:

- In 2010 a total of about USD 700 and labor for dredging was contributed by farmers.
- In 2011 about USD 2,900 was contributed by the farmers.
- In 2011 UNEP provided funding of USD 13,200 via EPA to FORS to work on the treatment ponds.

Maintenance of the system is done by the farmers. Dredging and removal of floating waste takes place two to three times a month depending on how chocked the system is, which varies between seasons. To dredge, 12–20 farmers work together. In addition to dredging, sacks are filled with sand to divert wastewater from the main river course into the constructed lagoons. Farmers estimated that about 150 sacks priced at USD 0.50 per sack are needed (i.e. total USD 75). Following heavy rains, the man-made dams usually need repair or reconstruction, and this is done three to four times a month. Over four months of rain, maintenance costs can exceed USD 1000. The contribution to maintain the wastewater is done by farmers as the situation arises, i.e. regular fees are low but when there is a need to work on the system, farmers are required to add additional money, with differences on where one's farm is located, i.e. how much farmers benefit. Farmers who were interviewed confirmed that despite these investments, their returns are multiple times higher than their costs[9].

In June and July 2014, severe flooding and sedimentation damaged the system, and its operation was paused[10]. A revised treatment system has been proposed by FORS to expand the present capacity of treatment and also improve the efficiency of the system. The new design will expand the size of the planted lagoons and intends to increase the share of water flowing by gravity to individual farms instead of being pumped. Buying or renting portable pumps also increases the initial investment of farmers especially those whose farms are located farther away from the treatment lagoons on top of investing in PVC pipes which can reach USD 500.

In an attempt to protect the site, improve the revenue streams and also maintain the ecology of the site, FORS in collaboration with UNEP and EPA has planted about 1,500 coconut seedlings at the site.

Socio-economic, health and environmental impact

Most of the farmers operating on the open wetland area practice commercial agriculture and produce fresh vegetables and cereals for sale in the city. The availability of water throughout the year gives them a competitive advantage. Although 90% of the about 200 farmers are men, more than the same number of women find employment as field workers for planting, weeding and harvesting; and women dominate trade and retail of most perishable vegetables.

The use of highly polluted water poses risks to farmers and consumers, and the initial mitigation measures by farmers are only one step on a longer journey. A microbial risk assessment estimated a possible loss of about 12,000 disability-adjusted life years (DALYs) annually in Ghana's major cities through the consumption of salad prepared from wastewater-irrigated lettuce (Drechsel and Seidu, 2011). This figure represents nearly 10% of the World Health Organization (WHO)-reported DALY loss occurring in urban Ghana due to various types of water, sanitation and hygiene-related diarrhea. Thus, the shift to partially treated irrigation water has been appreciated although more awareness creation on health benefits is needed to establish a related "safer food" value chain where premium prices make investment and behavior change of traders worthwhile (Keraita and Drechsel, 2015). So far, farmers appreciate the increased water proximity, storage and separation of solid waste more than possible health benefits. However, farmers also indicated their support for treatment measures improving the smell of the water. Farmers' willingness to invest in better water was also confirmed by Amponsah et al. (2016) in Kumasi (Ghana) showing that 60% of surveyed open space commercial vegetable farmers were willing to pay for reclaimed water for irrigation.

Women traders who were interviewed appreciated farmers' efforts at Sakumo as it has created a good image that the vegetables are cleaner. However, this does not prevent traders from mixing vegetables produced under safer and unsafer conditions. More consumer awareness is needed as well as public controls to keep the two value chains separate. The investment would pay off as every USD spent in on-farm treatment and post-harvest safety returns up to USD 4.9 in public health cost savings (Keraita et al., 2015).

Farmer support of waste management in this area will have benefits beyond the farms. The wetland provides valuable products and services, which include the provision of important spawning and nursery grounds for many fish species. It is absorbing floodwaters and protecting biodiversity. The wetland also serves as roosting, nesting and feeding sites for many species of birds (Entsua-Mensah et al., 2000). The site is rated the third most important for seashore birds along Ghana's coast. More than sixty bird species have been identified including six internationally important species.

Scalability and replicability considerations

Farmers' innovation capacity is well known (Reij and Waters-Bayer, 2001) and has been reported also from other countries where wastewater irrigation is common (Buechler and Mekala, 2005). The innovation requires relatively low investment costs and can easily be replicated on similar (peri)urban farming sites. Depending on the scale of local risk awareness, capacity development and further incentives would be supportive. The key drivers for the Sakumo case are:

- A business advantage for farmers to engage (as an organized group) in on-farm intervention, driven in this case by their desire to channel the water closer to their plots, create storage facility for periods of low flow, filter floating (plastic) debris, and remove bad water smell. A very similar situation exists, e.g. on the La farming site in Accra.
- An advantage for the local community interested in the protection and image of their wetland which has both a traditional role as well as a potential value for recreation and tourism (bird watching), and the formation of a related interest group (FORS) supporting the farmers.
- An enabling environment where policies, authorities and international agencies are supportive of the community efforts.
- A favourable cost-benefit ratio based on the additional cultivation area (and less production risks).
- Knowledge on technical options able to link farmers' interest with water quality treatment.
- Sense of ownership of the infrastructure by farmers and willingness to contribute to its O&M.

This business case presents a low-cost effort where simple technology provided a first step towards safer water reuse and there are more irrigation infrastructure options, in particular weirs (Ensink et al., 2010), which support natural remediation processes, independently if implemented with or without risk awareness.

However, to maintain and extend the treatment process, risk awareness supported by demand for safer food would be helpful. Value chains linking to dedicated outlets, like particular 'food quality' markets could be a start. The model would also gain in sustainability if EPA or MoFA could regularly monitor water quality and support farmers and traders complying with on- and off-farm safety protocols. The WHO (2015) *Sanitation Safety Planning Manual* provides a framework for such a process, which will facilitate further up- and out-scaling.

Potential risks and mitigation

In designing any business model, it is assumed that generic business risks are known and will be taken care of. However, some risks might be more model specific and will be acknowledged in the following:

Market risks: Like in the here presented case of Accra, most farming locations where wastewater is informally used are in close proximity to major urban markets and well positioned to respond quickly to market needs, save on transport costs, and deliver high-value crops also in the lean season when revenues peak. As crops produced with wastewater or freshwater are with few exceptions mixed in markets and risk awareness along the food chain is commonly low, market incentives for safe production remain limited, while urban demand for vegetables is high.

Competition risks: This is only possible where with increasing risk awareness along the food chain, the potential of competition from freshwater farmers is growing. So far this awareness is in most low-income countries limited and competition is stronger from the other end, i.e. farmers using raw wastewater without any investments (extra costs) in safety.

Technology and performance risks: The employed technologies are low-cost and mostly based on manual work, where one-time or seasonal investments in irrigation infrastructure pay off through reduced operational (labor) costs. As wetlands in coastal areas also function as buffer for flooding, the system has to withstand flash floods.

Political and regulatory risks: A significant challenge can come from the regulatory framework if this is not supporting. While in Accra, the use of wastewater for crop production is forbidden by local byelaws, Ghana's national irrigation policy is supporting the WHO (2006) guidelines which recommend a step-wise approach to move towards safer wastewater irrigation (Drechsel and Keraita, 2014).

Social equity related risks: The share of men and women in the informal irrigation sector differs between countries and cultures from mostly female, e.g. in Sierra Leone, to mostly male, e.g. in

TABLE 64. POTENTIAL HEALTH AND ENVIRONMENTAL RISK AND SUGGESTED MITIGATION MEASURES FOR BUSINESS MODEL 24

RISK GROUP	EXPOSURE					REMARKS
	DIRECT CONTACT	AIR/ ODOR	INSECTS	WATER/ SOIL	FOOD	
Farmers	HIGH RISK	MEDIUM RISK	HIGH RISK	HIGH RISK		After introduction of farm based risk reduction measures, their adoption has to be monitored
Community		MEDIUM RISK	MEDIUM RISK	HIGH RISK		
Consumer					HIGH RISK	
Mitigation measures				Pb Hg Cd	Pb Hg Cd	

Key: NOT APPLICABLE | LOW RISK | MEDIUM RISK | HIGH RISK

Senegal (Drechsel et al., 2006). There is no difference in innovation capacity although some of the innovations are very labor intensive. In the presented case study, both gender are equally presented within the overall value chain from farm to market.

Safety, environmental and health risks: The model follows the WHO (2006) recommendation of a step-wise and stakeholder inclusive approach to risk mitigation which is an intermediate step until (a) more comprehensive wastewater collection and treatment systems are in place; and (b) stricter safety guidelines can be implemented and enforced. In this sense, there are significant risks remaining – although less than without farmers' innovative efforts – which need to be controlled (Table 64). While pathogen loads can be reduced through on-farm treatment, other health risks will not be eliminated and additional preventive measures are required.

SWOT analysis and business performance

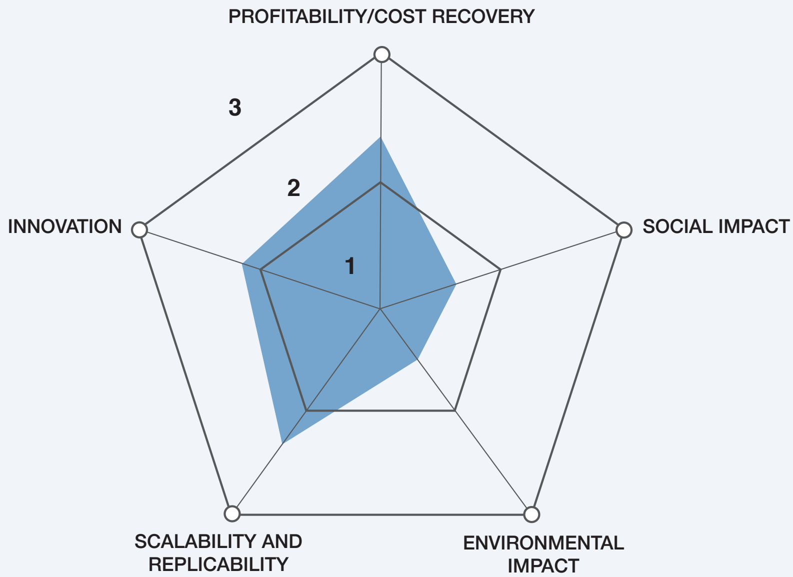
While this business case focused originally on supporting urban agriculture with better access to irrigation water, the installed pond system has the potential to improve also water quality and food safety. If combined with awareness creation and monitoring, incentives can be created to expand the system to progress gradually from informal to formal wastewater use. Similar synergies between

FIGURE 275. SWOT ANALYSIS OF SAKUMO WASTEWATER TREATMENT CASE, GHANA

	HELPFUL TO ACHIEVING THE OBJECTIVES	**HARMFUL** TO ACHIEVING THE OBJECTIVES
INTERNAL ORIGIN ATTRIBUTES OF THE ENTERPRISE	**STRENGTHS** ▪ Strong farmer's association with formal rules ▪ Willingness of farmers to invest in the set-up and maintenance of the treatment system ▪ Partnership with an NGO (FORS) able to advocate farmers interest and leverage funds ▪ Involvement of different institutions such as EPA, Forestry commission, UNEP, local chiefs ▪ Low O&M cost and the system can easily be upgraded ▪ Higher safety than in a business-as-usual scenario	**WEAKNESSES** ▪ The achieved treatment level is only an initial step in the right direction ▪ Farmers are more concerned with visible trash (e.g. plastic blocking pumps) than pathogens in the water, and might bypass designed treatment process ▪ Difficulty in expanding the scheme in the region due to only emerging 'safe food' awareness and marketing ▪ Inadequate monitoring of water quality to verify/improve treatment quality ▪ System reconstruction requires resources if severely damaged through flooding
EXTERNAL ORIGIN ATTRIBUTES OF THE ENVIRONMENT	**OPPORTUNITIES** ▪ Treatment system addresses demands related to water quantity and quality ▪ Opportunity for higher yields/extra harvest ▪ Environmental benefits from reduced trash and wastewater in the Sakumo lagoon ▪ New revenue option for (male) farmers and (female) traders based on increasing awareness for food safety ▪ Farmers' occupational health risks are controllable	**THREATS** ▪ Despite multiple strong stakeholders, and public interest in food safety, no institution accepts so far responsibility to assist farmers regularly ▪ Remaining crop contamination risks ▪ Remaining farmer exposure ▪ Urban encroachment on the site ▪ Septage operators dumping raw sludge into the wetland and wastewater inflow continues to increase ▪ Flooding destroying nature based treatment ponds

private and public interests are possible in view of the timing of irrigation (see above) and other farming practices (IWMI 2008a, b). This creates potentially a win-win situation whereby the city's wastewater undergoes a first treatment and farmers get access to more and safer irrigation water than without the intervention, resulting in higher returns and relatively safer food for consumers than in a business as usual scenario. However, the Sakumo water treatment system will not eliminate health risks and other risk mitigation measures have to be added between 'farm and fork' (Amoah et al., 2011). Figure 275 shows the SWOT analysis for the business case, while Figure 276 shows the impact potential of a farmer innovation model for increasing food safety.

FIGURE 276. IMPACT APPRAISAL FOR A FARMER-INNOVATION BASED BUSINESS MODEL FOR INCREASED FOOD SAFETY



As the model is only a building block on the trajectory from unsafe to safe wastewater use, its impact remains modest. Although the technical innovation is down to earth, the effort to create a win-win situation between farmers' initial interests and safeguarding public health is very innovative. Where this engagement can be supported, the model will rank well in view of scalability and replicability without undermining the profitability of the business for farmers (Figure 276). The cost-benefit balance might shift through the introduction of more advanced and capital or maintenance intensive on-farm technologies. Thus, any replication or expansion should be aligned with the support of a value chain which targets (the increase of) market segments cherishing food safety.

Contributors

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Members of the Resource Users Association at the site
Richard Agopa, Friends of Ramsar Site, Tema, Ghana

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Case and model descriptions are based on primary and secondary data provided by case operators, insiders or other stakeholders, and reflect our best knowledge at the time of the assessments 2015. As business operations are dynamic data are likely subject to change.

Notes

1 www.ramsar.org/about-the-ramsar-convention (assessed 4 Nov. 2017).
2 GTV news video (www.youtube.com/watch?v=CGZVW4nb7cc; assessed 4 Nov. 2017).
3 https://rsis.ramsar.org/ris/565 (assessed 4 Nov. 2017).
4 This is an interesting example where farmers changed behavior, probably to avoid traders to reject their 'smelly' produce, which in fact supports the natural die-off of pathogens as recommended by WHO (Keraita et al., 2007).
5 As an association, farmers have an increased ability to offer traders a higher and more reliable supply at lower contracting costs (one-stop-shop). Moreover, a registered association can easier access agricultural loans and possibly use its cooperative capital as collateral for fund raising.
6 While the protection of the wetland has to start upstream where pollution is generated, EPA struggles with the lack of sewage collection and treatment.
7 In 2014, the Resource Users Association and local fishermen registered as an official association under the companies act and the name of "Sakumo Ramsar Conservation and Resource Users Association". www.ghananewsagency.org/social/users-of-sakumo-wetland-form-association--76109 (assessed 4 Nov. 2017).
8 Ghana's Environmental Protection Agency (EPA) and the United Nation Environment Programme (UNEP) initiated in 2013–2014 an afforestation project of planting mangoes and coconuts in the wetland area. The trees should provide income and prevent further encroachment and land degradation.
9 See also www.youtube.com/watch?v=CGZVW4nb7cc (assessed 4 Nov. 2017).
10 Famers continued using the treatment infrastructure for their own advantage, including abstracting water also from the treatment lagoons nearest to their farm. At the time of writing in late 2016, FORS was still seeking support for system repair and extension.