

Water Research

SaWaFo: Safe Water for Food Research & Projects



1. Background of SaWaFo

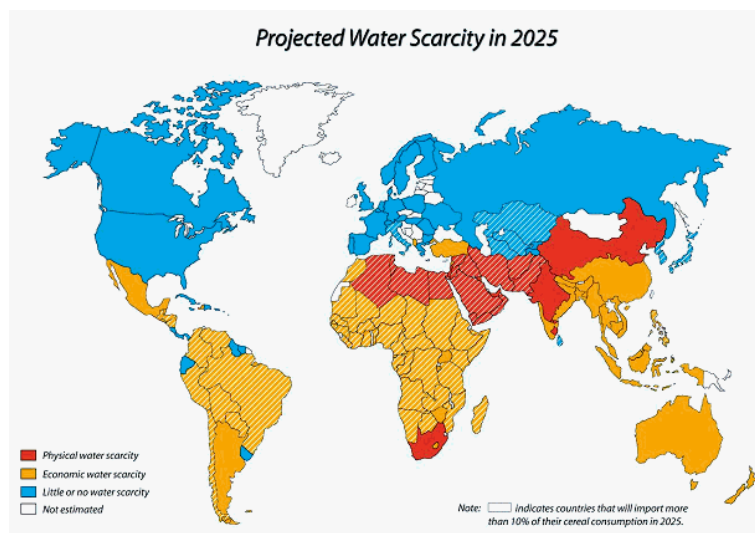
Urban and peri-urban vegetable farming has been an important source of livelihoods and food security for the growing number of urbanites in the world (Gallaher et al., 2013; Knoblauch, 2012). Several scholars, policy makers and development practitioners across the globe place urban vegetable farming high on the sustainable city global agenda (sources). However, the growing water scarcity in the world (Kummu et al., 2010; Munia et al., 2016) threatens the sustainability of urban and peri-urban vegetable farming. As a coping strategy, urban vegetable farmers have resorted to the use of wastewater for irrigation (Adewumi et al., 2010; Alfarra et al., 2011; Jiménez et al., 2010; Kretschmer et al., 2010; Pedrero et al., 2010), which has the tendency to undermine public health. Embargoing untreated wastewater reuse for irrigation in order to protect public health could have adverse implications for the sustainability of the livelihoods along the urban and peri-urban

vegetable supply chain. Therefore, city authorities are faced with the dilemma of sustaining these livelihoods and protecting public health.

The answer to the dilemma lies in the World Health Organisation's Multiple Barrier Interventions. These are a set of situation-specific health risks reduction measures that

are known to reduce the burden of diseases associated with the use of wastewater for irrigation purposes. Designed to be consistent with the hazard analysis and critical control path (HACCP)

concept (Keraita et al., 2010), the interventions help in the identification of the sources of hazards in the vegetable supply chain in order to reduce the probability that these hazards would occur at any point of the chain. These interventions include cessation of irrigation days before harvest, reduction of splashing and

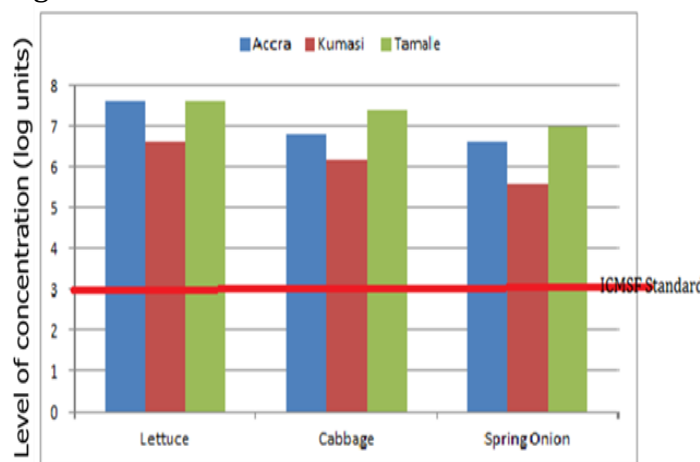


furrow irrigation, which should be combined with farm-based and low-cost non-treatment options such as simple sedimentation, simple filtration and the three-tank system (Drechsel and Seidu, 2011).

In this regard, the Ministry of Food and Agriculture in Ghana has adopted the Multiple Barrier Interventions in the National Irrigation Policy, Strategies and Regulatory Measures.



The specific policy provision is "support best practices for the safe use of marginal quality water in accordance with the WHO guidelines for the safe use of wastewater, excreta and greywater in agriculture" (MoFA, 2011: 13). The Multiple Barrier Interventions are what the policy refers to as "best practices". However, after seven years of implementation, the policy is yet to guarantee the safety of the vegetables that are produced by urban and peri-urban vegetable farmers.



The *Safe Water for Food (SaWaFo) project*, which is a research partnership among DHI - Denmark, Kwame Nkrumah University of

Science Technology - Kumasi and Sokoine University of Agriculture – Morogoro and financed by the Danish Ministry of Foreign Affairs, was



commissioned to assess the health risks associated with the use of untreated wastewater for irrigation and determine the factors that have undermined the effectiveness of the policy provision on wastewater reuse for irrigation purposes.

The results of the project and the policy recommendations are presented in this policy brief.

2. Research Procedure

The research combined a myriad of approaches to a) estimate the possible health risks associated with wastewater irrigation and b) determine the factors that have undermined the effectiveness of the policy provision on wastewater use for irrigation.

2.1 Estimation of the Possible Health Risks

Possible health risks were estimated using a probabilistic approach from a technique known as Quantitative Microbial Risk Assessment. This technique enables to build a probabilistic mathematical models adapting to different realistic scenarios. It gives the leverage of quantifying both uncertainty and variability surrounding input parametric values for the risk assessment and makes it possible to separate uncertainty from variability in the models. This leverage also helps in quantifying the available data for risk assessment not only with mean values, but with probabilistic distributions describing the available datasets. Possible risk estimates were made through different scenarios of exposure to low quality water and quantified using the Disability Adjusted Life Years approach (DALYs).

2.2 Understanding the Ineffectiveness of the Low Quality Water Reuse Policy

First, the Irrigation Policy document was assessed for completeness, consistency with other sector policies in Ghana and harmony with Ghana's sustainability aims. This was followed by a survey of 100 vegetable farmers, 129 vegetable sellers, 148 street food kitchen operators, 47 restaurant operators and 153 vegetable consuming households in Kumasi, Ghana's second largest capital. Supplementary data were also obtained from relevant national and local institutions.

Analysis of the primary data focussed on the awareness and adoption of the WHO's MBIs by the actors along the vegetable supply chain.

2.3 Elicitation of Inputs for this Policy Brief

The results of the study were presented to relevant stakeholders on three different meetings (on 17th November, 2016; 28th February to 9th March 2016; and 24th – 26th May, 2017).



The purpose of these meetings was to validate the results of the study and elicit ideas from participants on practical ways of ensuring the safety of vegetables produced by urban and peri-urban farmers without compromising livelihoods.

3. Research Results

3.1 Overview of the Health Risks Associated with Wastewater Irrigation

The results of the study show that farmers, through the use of untreated wastewater for irrigation purposes, without adherence to safe irrigation practices, contribute to the

contamination of ready-to-eat vegetables. Consequently, 9 out of 10,000 people, which is approximately nine-fold the World Health Organisation's benchmark of 1 out 10,000 people, are at risks of infections.

3.2 Effectiveness of the Multiple Barrier Interventions

The results presented in Table 1 indicate that the farm-based multiple barrier interventions are effective in reducing the possible health risks associated with the use of untreated wastewater for irrigation.

Table 1: Effectiveness of the On-farm MBIs

Individual dose models	Probable risks	WHO Benchmark
Raw wastewater	9 in 10,000 people	1 in 10,000 people
Simple Sedimentation	1 in 10,000 people	
Three-tank system	2 in 10,000 people	
Simple filtration	8 in 10,000 people	

The off-farm Multiple Barrier Interventions are also known to remove further some of the pathogens that may have been transferred from the farms (Table 2).

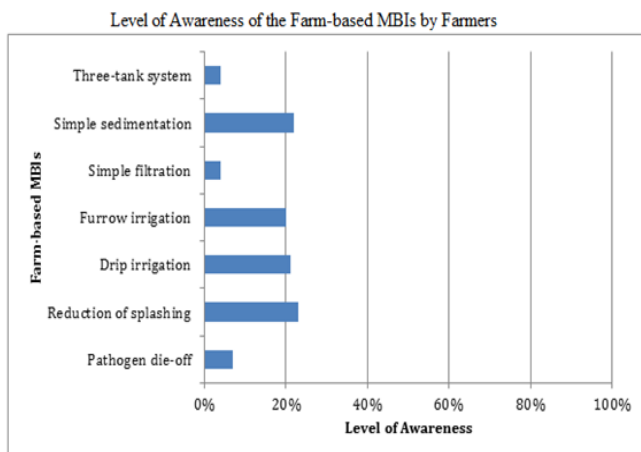
Table 2: Amount of Pathogens each MBI is capable of removing

Off-farm interventions	Reduction	Comments/Remarks
Washing of produce with clean water	10	Washing salad crops, vegetables and fruit with clean water
Application of disinfection	100	Washing salad crops, vegetables and fruit with a weak disinfectant solution and rinsing with clean water.
Peeling of produce	100	Fruits and root crops
Cooking of produce	1,000,000-10,000,000	Immersion in boiling or close-to-boiling water until the food is cooked for some period of time to ensure pathogen destruction

The fore-stated results imply that adoption of the multiple barrier interventions by the economic actors and households along the vegetable supply chain would promote the safety of the vegetables and public health. Adoption of the multiple barrier interventions is the answer to the dilemma of sustaining livelihoods and protecting public health.

3.3 Awareness and Adoption of the Multiple Barrier Interventions

The level of awareness of the farm-based multiple barrier interventions was low among the vegetable farmers that were covered in the study. Those who were aware of the interventions had participated in field trials and workshops that were aimed at introducing farmers to safe irrigation practices.



Due to the low level of awareness, the adoption of the farm-based multiple barrier interventions was very low. The option that received the highest level of adoption was reduction of splashing (with only one out of 10 farmers adopting it). A key barrier to adopting the interventions among those who were aware of them was land tenure insecurity. The farmers received incessant threats of eviction.

Unlike the vegetable farmers, almost 8 out of every 10 vegetable sellers were aware of the effectiveness of 'washing with clean running water'. Almost half of the vegetable sellers were aware of the effectiveness of 'removal of outer leaves' and 'storage in baskets'. However, only one of every three vegetable sellers practiced 'removal of outer leaves' and 'storage in baskets'

whereas only 5% adopted 'washing with running tap water'.

The levels of awareness and adoption of the kitchen-based practices were high among the end users of the vegetables. All the street food kitchen operators, restaurant operators and vegetable consuming households knew the effectiveness of a) washing with clean, b) application of disinfectant, c) peeling and d) cooking.

However, the systematic nature of the multiple barrier interventions requires adoption not only by a section of the stakeholders along the vegetable supply chain but all the stakeholders. The non-compliance of the multiple barrier interventions by the vegetable farmers in particular and a section of the vegetable sellers could explain the failure of the wastewater reuse policy provision to guarantee the safety of the vegetables.

An attempt was made to understand the stakeholders' low level of awareness of the multiple barrier interventions. This led to the assessment of the adequacy of the policy, its compatibility with other sector policies and its consistency with Ghana's sustainable development aims.

3.4 Assessment of the Policy

As indicated earlier, the wastewater reuse policy provision is based on the evidence of the effectiveness of the multiple barrier interventions. The results show that not only is it compatible with other sector policies in Ghana, it is also consistent with Ghana's sustainability aim as evident in the framework for Strategic Environmental Assessment (SEA). However, wastewater reuse for irrigation takes place mainly in the informal irrigation sub-sector, which is outside the jurisdiction of the Ghana Irrigation Development Authority (GIDA). This means that there are no promotional activities and that GIDA can promote the multiple barrier interventions at the farm levels only if the Ghana Irrigation Development Authority Regulations 1987 (LI 1350) is amended to give the institution jurisdiction over informal irrigation.

Due to the lack of promotional activities for the safe use of wastewater for irrigation, a number of decentralised institutions whose mandates could impact the policy implementation were unaware of the wastewater reuse policy provision. These institutions also considered

untreated wastewater reuse for irrigation purposes as inappropriate.

Awareness and Perception of Local Institutions about Wastewater Reuse Policy Provision

Institution	Awareness of policy		Awareness of promotional activities		Perception (- or +)	Institutional perception Remarks
	Not aware	Aware	Not aware	Yes, Aware		
MADU	✓		✓		-	"The WHO guidelines come with its own technological requirements that are not possible to localise in Ghana. Wastewater contains some contaminants like pathogens and chemicals that can only be removed through treatment".
Metropolitan Health Directorate	✓		✓		-	"We are unaware of wastewater reuse policies in Ghana. If there is then we are certainly not involved with its implementation".
Waste Management Department	✓		✓		-	"Our mandate is to manage all types of waste in the metropolis. We are, however unaware of any policies that provide for wastewater use in an untreated form".
Environmental Health Department	✓		✓		-	"Wastewater contains <i>E. Coli</i> eggs and other pathogens which contaminate the vegetables they are produced with. In this vein, untreated wastewater use in agriculture is not advisable".
Environmental Protection Agency	✓		✓		-	"Wastewater should be used after careful treatment. We are interested in seeing a country where wastewater is treated before discharge. In this regard, its use in agriculture will not be a problem".
Food and Drugs Authority, Kumasi	✓		✓		-	"We do not know of any policies in Ghana that encourage wastewater reuse in untreated form".
Ghana Standards Authority, Kumasi	✓		✓		-	"Wastewater which by itself is not edible should not be used for agricultural purposes, unless it has been treated to permissible levels of contamination".

4 Policy Recommendations

4.1 Sustaining Commercial Vegetable Farming in Urban Areas

The following proposals are recommended:

- a) Land tenure security for urban vegetable farming. This can be realised if the Irrigation Development Authority, like the Volta River Authority in Ghana, is given the mandate to control the irrigation lands in urban areas. This strategy will ensure that the lands continue to be used for agricultural purposes. Central and local government bodies should also acquire lands in peri-urban areas, compensate the landowners and dedicate these lands to vegetable farming. With land tenure security and no fear of eviction, the vegetable farmers would be willing to invest in their farms and that could ultimately enhance the safety of the vegetables.

- b) Establishment of farm-field schools and Cooperatives. The farmer field schools would enhance accessibility to the farmers for educational campaigns. The cooperatives would also enhance the farmers' access to formal credit for investment.

4.2 Safety of the Vegetables

The following proposals are recommended:

- a) Preparation and enforcement of safety guidelines. These safety guidelines should be based on the hazard analysis and critical control point (HACCP) concept. The Food and Drugs Authority, Water Resources Commission, Ministry of Food and Agriculture, the Ghana Tourism Authority and all relevant stakeholders, together with the vegetable farmers, sellers, cooks and consumers should collaborate to develop national guidelines on how the World Health Organisation's multiple barrier interventions should be applied on the farms, at the markets and in the kitchens.

- b) Provision of safe water (pipe-borne) at the vegetable point of sale to for safe washing before sale. This should be complemented by education on safe vegetable washing and handling practices.
- c) Continuous awareness creation on how to make vegetables safe for consumption through the media and community information centres. The National Communication Authority should encourage media houses to devote 10 – 15 minutes of their daily air times to health education, which would include the safe use of vegetables.
- d) Certification and packaging. The vegetable farmers in the cities should be certified to facilitate tracing. The farmers and sellers should also be educated on the safe packaging of the produce to reduce the possible health risks associated with the use of untreated wastewater for irrigation.

Acknowledgements

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e) Further reading

- Amponsah, O., Vigre, H., Braimah, I., Schou, W.T., Abaidoo, R.C., 2016. The policy implications of urban open space commercial vegetable farmers' willingness and ability to pay for reclaimed water for irrigation in Kumasi, Ghana. *Heliyon* 2, 1–38.
- Amponsah, O., Vigre, H., Schou, T.W., Boateng, E.S., Braimah, I., Abaidoo, R.C., 2015a. Assessing low quality water use policy framework: case study from Ghana. *Resources, Conservation and Recycling* 97, 1–15.
- Amponsah, O., Vigre, H., Schou, T.W., Braimah, I., Abaidoo, R.C., 2015b. The impact of farmers' participation in field trials in creating awareness and stimulating compliance with the World Health Organization's farm-based multiple-barrier approach. *Environment, Development and Sustainability* 17.
- Sampson, A., Owusu-Ansah, E. de-G.J., Mills-Robertson, F.C., Ayi, I., Abaidoo, R.C., Hald, T., Permin, A., 2017. Probabilistic quantitative microbial risk assessment model of farmer exposure to *Cryptosporidium* spp. in irrigation water within Kumasi Metropolis-Ghana. *Microbial Risk Analysis* In Press.

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