Institutional barriers to food safety in the urban irrigated vegetable value chain in Accra, Ghana

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Abstract

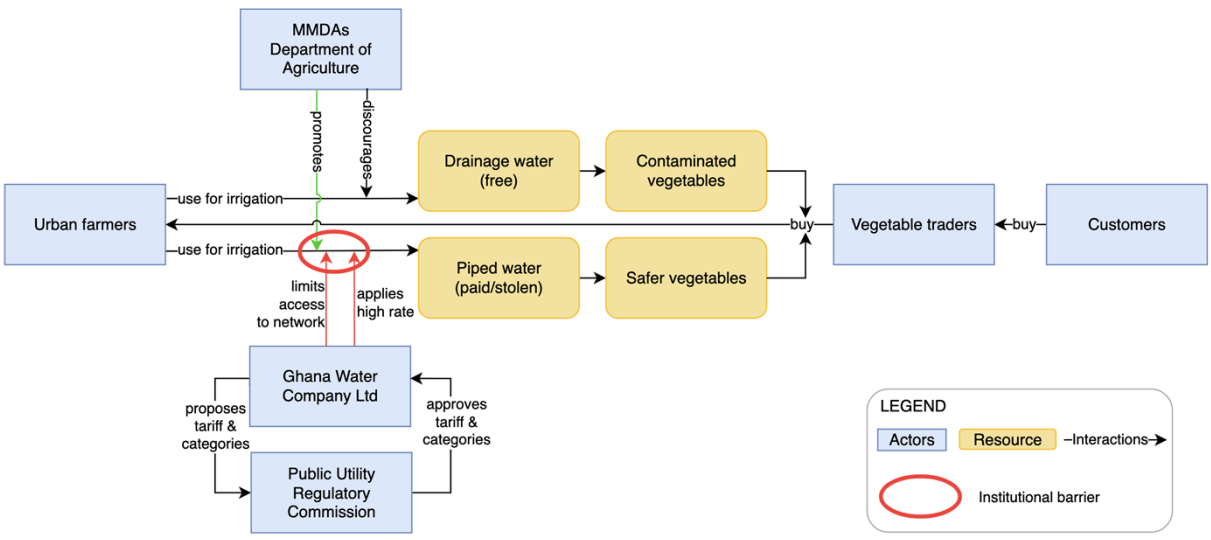
The faecal contamination of irrigation water threatens public health. Although safe practices can mitigate hygiene and food safety risks along the urban irrigated vegetable value chain, their adoption remains limited. A behaviour framework was combined with a participatory approach to explore how institutions influence farmers' capability, opportunity and

motivation to adopt safe practices in Accra, Ghana. After extensive preparation, a dialogue engaged stakeholders and institutions in identifying the actors and interactions influencing stakeholder practices. We find that institutional dynamics hinder farmers' opportunity and motivation to adopt safe practices. Knowledge gaps created by top-down approaches and sectoral silos were bridged by engaging participants in conducting the behavioural diagnosis. This shared understanding enables participants to co-design arrangements that make safe practices easier to adopt.

Keywords

Sanitation, urban agri-food systems, multiple barrier approach, risk management, COM-B, Companion Modelling

Graphical abstract (optional)



Introduction

Over 1.7 billion people in cities of Low- and Middle-Income Countries (LMICs) do not have access to safely managed sanitation (1). This leads to the faecal contamination of surface water that urban farmers need to irrigate the vegetables they supply to these cities (2–4). Perishable vegetables, essential to a healthy diet, are expensive and difficult to transfer from rural areas to cities without adequate cold transport and storage (5,6). Consequently, urban and peri-urban farmers produce most of the leafy greens consumed in cities and do so year-round thanks to irrigation (7). Many of these leafy greens are consumed raw as salads or toppings on other dishes, making raw produce and street food leading exposure pathway to faecal contamination in many LMIC cities (8,9), exposing farmers, vegetable traders, street food vendors and consumers to diarrhoeal and parasitic infections (8–11). Contaminated vegetables contribute to 420,000 annual deaths and 600 million illnesses from foodborne diseases, costing over USD 100 billion in LMICs (12,13). Moreover, pathogens can also lead to severe public health crises, such as the 2024 cholera outbreak in Ghana, which led authorities to ban vegetable sales (14). Food security and nutritious diets must not come at the expense of food safety (15,16).

While achieving universal, safely managed sanitation remains a long-term challenge (17), the World Health Organization's multiple-barrier approach recommends that stakeholders adopt safe practices to mitigate the risk of faecal contamination along urban irrigated vegetable value chains, 'from farm to fork' (18). Practices include simple on-farm water treatment and non-treatment options, such as growing crops not eaten raw, adopting different irrigation regimes, or washing vegetables safely. Despite its benefits, the uptake of this approach

remains low (19). The *COM-B* behavioural model posits that adoption requires stakeholders to have the *Capabilities*, *Opportunities*, and *Motivations* to perform safe *Behaviours* (20). Top-down approaches and barriers between water, agriculture and health sectors prevent comprehensive identification of stakeholders' Capability, Opportunity, and Motivation needs (21). Additionally, misaligned priorities lead institutions to hinder stakeholders' capabilities and opportunities to adopt safe practices recommended by other institutions (22).

Accra's urban farmers face this situation. Agricultural extension agents from the Municipal Departments of Agriculture and Public Health motivate farmers to use piped water instead of surface water to reduce faecal contamination (23). However, the water utility often hesitates to connect farmers willing to use piped water to the piped network, prioritising domestic customers (23). Since under 10% of faecal sludge is treated, over a thousand farmers use contaminated water to irrigate leafy greens, and about 15,000 street food vendors serve these vegetables raw to over 85% of the city's population (24–28). Contaminated vegetables are a primary source of faecal exposure for adults and children in Accra, as well as many LMIC cities, where the burden of foodborne diseases is likely to increase as diets transition to include more raw vegetables (12,27,29,30).

This study aimed to diagnose the institutional factors hindering farmers' *capability, opportunity* and *motivation* to adopt safe irrigation practices. We invited stakeholders and institutional representatives to dialogue, share experiences and develop a shared understanding of the challenges. To our knowledge, this study is the first to combine a behavioural framework and a participatory approach for stakeholders and institutions to co-develop a systematic and comprehensive evidence-based behavioural diagnosis and actionable insights to implement a multiple barrier approach. These insights are key to co-

78 designing arrangements that enable farmers and other stakeholders to enhance hygiene and
79 food safety. The process and insights are also relevant for the many cities where irrigated
80 vegetable value chains depend on contaminated water.

81 The subsequent method section outlines how we integrated WHO's multiple barrier
82 approach, the COM-B behavioural framework and a participatory method in a
83 multistakeholder dialogue. We then present participants' perspectives, analyse institutional
84 influences, and elaborate on the shared understanding that emerged from the dialogue. We
85 reflect on the process before concluding.

86

87 Methods

88 This study combines a behavioural theoretical framework and a participatory approach to
89 analyse how institutional obstacles hinder hygiene and food safety along Accra's irrigated
90 vegetable value chain. The following section describes how these concepts complement each
91 other (see also Figure 1).

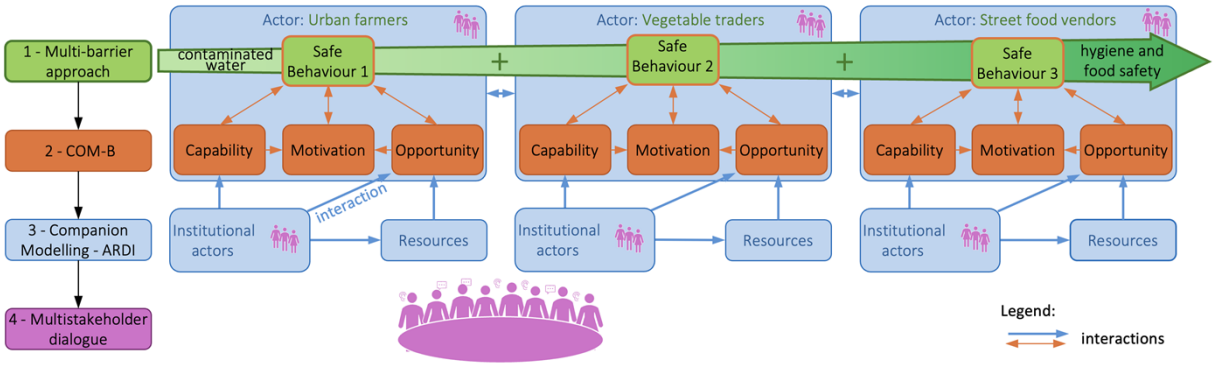


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Figure 1 - Integrative conceptual framework for exploring institutions' influence on stakeholders adopting safe practices to increase hygiene and food safety

To protect public health, the WHO recommends a multiple-barrier approach whereby stakeholders adopt a combination of safe practices 'from farm to fork' (18). Using the COM-B behavioural framework ensures all factors influencing stakeholders' adoption of these safe practices are considered. The Companion Modelling participatory approach helps operationalise the COM-B framework by enabling stakeholders and institutional representatives to participate in a dialogue to collectively develop a shared understanding of the *Actors*, *Resources*, *Dynamics* and *Interactions* (ARDI) that influence stakeholders' capability, opportunity and motivation to adopt safe practices. This strategy provides a systematic and comprehensive evidence-based behavioural diagnosis and actionable insights, which are prerequisites to designing an effective and sustainable intervention.

A previous formative study tracked vegetables from farm to fork, interviewing stakeholders along the value chain about their water- and food safety-related practices and the institutions that influence these (23). Here, "stakeholders" refers to farmers using contaminated water, traders buying and selling farmers' vegetables, street food vendors, and consumers. "Institutions" are the organisations, formal or informal, that determine the rules influencing stakeholders' adoption of safe practices. Institutions mentioned by stakeholders include the Departments of Agriculture of the Metropolitan, Municipal and District Assemblies (MMDAs), the water utility Ghana Water Company Ltd (GWCL), the Food and Drug Authority, whose representatives were subsequently interviewed. Analysis of these 75 interviews revealed that sectoral barriers leave intervening institutions unaware that institutions with other priorities may hinder stakeholders' adoption of the safe practices they recommend.

COM-B framework

Theory-based behaviour models help practitioners ensure they consider all factors influencing stakeholder behaviour. The COM-B model posits that for a stakeholder to adopt a safe practice or behaviour, they need to have the *Capability*, *Opportunity* and *Motivation* to perform that *Behaviour* (20). Capability, physical and psychological, includes the strength, skill, or knowledge needed to perform a behaviour. Opportunity, social and physical, refers to the external factors that make a behaviour possible or easier to perform, such as infrastructure or resource accessibility. Motivation refers to the mental processes, automatic or reflective, that drive behaviour performance. The Capabilities and Opportunities influence the Motivation, all three influencing and being influenced by the Behaviour, as illustrated in Figure 1. This model synthesises earlier models into a simple yet robust framework to understand what influences behaviour. Behavioural diagnosis is structured into diverse sectors, including some related to sanitation and hygiene (31), food safety (32), and policy development (33).

Companion Modelling approach and the ARDI method

This study draws on the Companion Modelling participatory approach (34,35) to facilitate behavioural diagnosis. It uses dialogue between stakeholders, institutions and researchers to enable them to learn from each other, provide continuous feedback and develop a shared understanding of the factors influencing the adoption of safe practices along the value chain. In particular, the study employs the ARDI method, one of the first steps of the Companion Modelling approach whereby participants identify the Actors, Resources, Dynamics and Interactions that shape a value chain (36). Systematically analysing these through the lens of

the COM-B model addresses the knowledge gaps around mechanisms by which institutions may impede stakeholders' adoption of safe practices along a value chain.

Multistakeholder dialogue

A multistakeholder dialogue was hosted at the International Water Management Institute (IWMI) in Accra on 13 September 2023. Beginning on 24 August 2023, invitations outlining its purpose and agenda were hand-delivered to urban farmers, vegetable traders and street food vendors involved in prior fieldwork. Invitations were also distributed to the directors of 17 institutions. Follow-up calls confirmed participants' attendance. The purpose and agenda were verbally clarified, and invitees who could not attend were requested to delegate a substitute. Almost all invitees responded positively. IWMI's history of action research in collaboration with urban farmers, government bodies, and research institutions in Greater Accra likely contributed to the high attendance. Previous interactions with farmers also fostered trust and engagement. Unfortunately, most vegetable traders and street food vendors could not attend due to timing conflicts with their income-generating activities. Some institutions delegated representatives from different services, while others assigned representatives at the last minute who lacked a proper briefing.

The dialogue brought together 29 participants (14 females and 15 males) representing 21 stakeholder groups and institutions (Table 1). During registration, participants provided contact details to record attendance and facilitate follow-up. They were reminded of the dialogue's objectives and informed that the session would be audio-recorded for research purposes before giving their informed consent.

160 *Table 1 Participants in the multistakeholder dialogue*

Stakeholder group	Institution	Number of participants
Farmers	Fiesta Royal farm	1
	Atomic Vegetable Farmers Association	1
	Dzorwulu farm	2
	Plant Pool farm	1
Wholesalers	Eden Tree Ltd	1
Local government	Accra Metropolitan Assembly, Department of Agriculture	1
	Accra Metropolitan Assembly, Department of Public Health	1
	Ayawaso West Municipal Assembly, Department of Agriculture	1
	La Dade Municipal Assembly, Department of Agriculture	1
National government & other public services	Environment Protection Agency (EPA)	1
	Food and Drug Authority (FDA), Food safety and Consumer Education	1
	Ghana Green Label	1
	Ghana Water Company Limited	1
	Land Use and Spatial Planning Authority (LUSPA)	1
	Ministry of Food & Agriculture, Directorate of Agricultural Extension Services (MoFA-DAES)	3

	Ministry of Food & Agriculture, Directorate of Crop Services (MoFA-DCS)	2
	Ministry of Food & Agriculture, Women in Agricultural development (MoFA-WIAD)	2
	Ministry of Local Government, Decentralisation and Rural Development (MLGDRD)	1
	Ministry of Sanitation and Water Resources (MSRW)	1
Research institutions	International Water Management Institute (IWMI)	4
	University of Ghana	1
TOTAL	21	29

161

162 The dialogue lasted five hours, facilitated by two researchers with expertise in agro-
163 hydrology, wastewater, food safety, and microbiology. The lead facilitator is the paper's first
164 author, who is also trained in COM-B and Companion Modelling. Most participants were
165 previously interviewed by the lead facilitator, offering continuity. Water-related practices
166 affecting hygiene and food safety 'from farm to fork' were presented to participants,
167 highlighting contamination sources and the economic burden of foodborne diseases. The
168 institutional barriers to the adoption of safe practices, identified during prior interviews, were
169 introduced by the lead facilitator. These included poor access to safe water for irrigation and
170 safe vegetable washing, lack of infrastructure and land tenure insecurity. Participants were
171 invited to share their perspectives and respond to each other's viewpoints, while the
172 facilitators guided the discussion to identify the Actors, Resources, Dynamics, and Interactions
173 at play for each barrier. Participants mentioned underlying factors and proposed and

evaluated potential solutions. To ease farmers' reluctance to challenge authorities, the lead facilitator agreed to present sensitive issues on their behalf.

Participants engaged in a candid and productive dialogue, remaining in a group discussion rather than breaking into activities as planned. The dialogue concluded with the participants summarising key insights, which the facilitators recorded on flip charts. Participants appreciated that such a range of stakeholders and institutions had agreed to discuss often-overlooked food safety concerns. As the Eden Tree representative stated: "Thank you very much for inviting me to this. I'm actually enlightened because, for so long, my perception was that nobody cared … [So much work has been done] but we don't know".

The dialogue transcript was manually coded to identify the Actors, Resources, Dynamics, and Interactions mentioned by participants. The coded data were then analysed using the COM-B model to systematically identify institutional barriers that affect stakeholders' Capability, Opportunity, and Motivation to adopt safe practices, which are discussed in the next section. To protect participants from potential negative consequences, statements on sensitive topics are attributed generically (e.g., 'a participant stated...') rather than to specific individuals. In some cases, attribution was not possible due to the dynamic nature of discussions involving multiple participants, where identifying individual speakers was not feasible.

Ethics statement

This study conformed with ethical protocols, which were approved by Loughborough University (ref 2022-7727-12403) and IWMI's Institutional Review Board in Ghana (ref 2023_04).

Results and discussion

Stakeholders' initial perspectives

The Departments of Agriculture and Public Health view urban farmers using piped water for irrigation as an easy solution to reduce faecal contamination and protect public health. Agricultural Extension Agents occasionally condition farmers' access to training, subsidies, and awards on their adoption of this safe practice. These Departments attribute low compliance to farmers' limited awareness of risk and lack of incentives, prompting them to prefer the uninterrupted supply of free surface water from canals over the safer yet charged for and intermittent supply of piped water.

GWCL's perspective is best reflected by a statement one of their representatives made in a formative interview, and that was repeated in the dialogue:

> When they [farmers] apply [for a connection], we do install, but we are not encouraged to connect them … because they will be billed at the commercial rate, and they can't pay. They can also leave their farm. The tendency for them to steal [piped water] is always there because of the rate [charged]. Just recently, in February-March [2023], the tariff has been increased by 167%. Even companies and other commercial users are finding it very difficult [to pay], let alone peasant farmers… We encourage them to sink boreholes.

Farmers using surface water argue that the intermittent supply of piped water disrupts their irrigation schedules. Those relying on piped water confirmed doing so only because they

cannot access surface water, raising complaints about issues including pipe bursts and infrastructure failures, leaving them without water for weeks. Their main concern is the rising cost of piped water, which makes bill payment difficult and can lead to disconnection. Reopening the connection involves long delays and extra fees. Utility agents may charge taxi fares and repair costs for interventions in the public domain, a common practice among underfunded public utilities (37).

Developing a shared understanding of the problem

Farmers saw their water bill increase in February 2023, unaware of GWCL's lower "non-residential" rate, which capped other small businesses at 8.3%. GWCL learned that local agricultural and health officials were promoting piped water for irrigation to enhance food safety. Other officials discovered that GWCL did not systematically connect farmers to the piped network and had received approval from the Public Utility Regulatory Commission (PURC) to charge a substantially higher rate than that for households or small businesses. The actors, resources and interactions discussed during the multistakeholder dialogue are modelled in Figure 2.

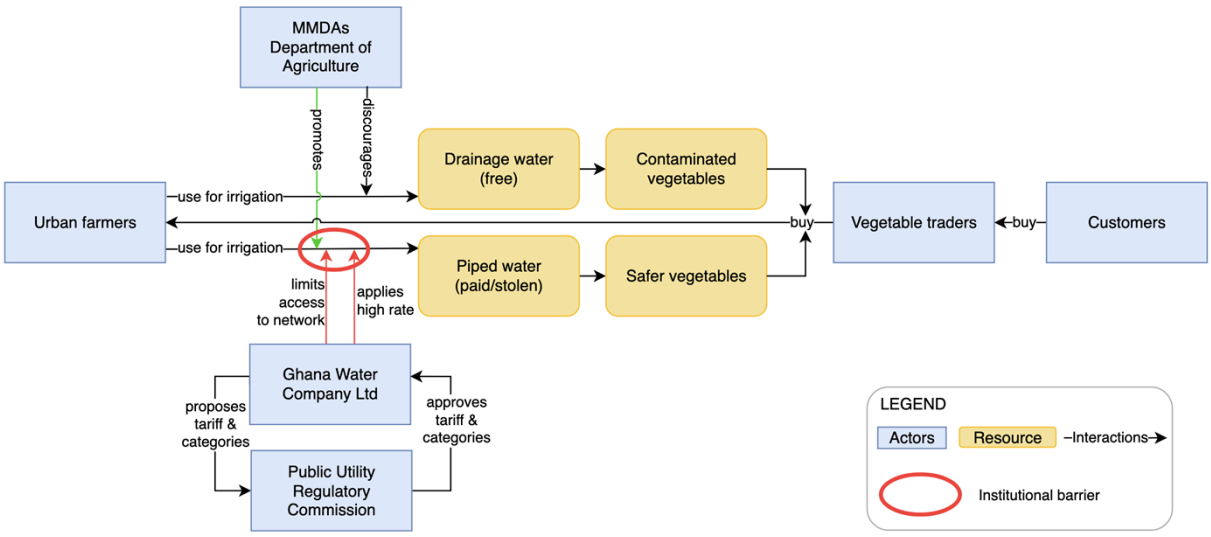


Figure 2 How actors and their interactions influence farmers' opportunity to use piped water

Agricultural officers, empathising with farmers, questioned the higher rate. The GWCL representative explained: "As long as you're using the water to enhance your business, you have to be on the commercial [rate]", before adding:

> Our priority is to supply water for domestic purposes and commercial … Initially, we didn't supply them [farmers] with water … But we realised that they also need the water … They're metered, but they don't pay … Certain areas like Plant Pool, they use a shared meter. So, if a farmer decides not to pay, … we have to cut supply to the area … The intermittent supply, we can't do anything about it. The raw water source that we have is a lot, but the infrastructure to treat this water and supply it to our customers is a challenge.

GWCL has increased tariffs despite abundant raw water resources to address rising production costs and utility debt. These have been exacerbated by a devalued national currency and a high non-revenue water ratio largely due to ageing infrastructure (38,39). Local GWCL officers know that urban farmers struggle to pay for water, but the utility prioritises cost recovery. This strategy discourages farmers who use surface water from switching to piped water and incentivises those who use piped water to steal it or revert to using surface water. As a farmer emphasised:

> Today [I pay] 2000 [cedi per month, about USD174 at the time], tomorrow 3000, 5000, 7000! All the farmers, it is just like we are stuck. ... If you don't make it affordable for me to work, either I steal from Ghana Water, or I use the stream [i.e., surface water]. If you make it affordable for me, I'll pay. But if you don't make it affordable, I'll use the alternative.

Some farmers lost their motivation to use piped water and reverted to surface water years ago when availability or cost became too challenging. Those without access to surface water lose the opportunity to irrigate altogether and reduce production, losing their livelihood and leaving the market to those using contaminated water. In both cases, hygiene and food safety are jeopardised.

Participants fear decision-makers underestimate the problem, not realising that all consumers may be exposed to contaminated vegetables and that urban farmers' irrigation practices are key. As a MoFA representative pointed out:

> We are all at risk because we don't know what we are eating. You can go to a hotel [restaurant], you don't know where they are sourcing their vegetables from, because I have seen people buying at places and their vehicles packed far away. So then you don't associate them with the source where they are buying these vegetables ... Now the chemical [contaminants take time] … but the microbial will kill you.

Through the multistakeholder dialogue, participants developed a shared understanding of the institutional barriers affecting farmers' access to piped water, bridging knowledge gaps across sectors. This process revealed how pricing policies, infrastructure limitations, and regulatory constraints shaped farmers' decisions, helping to map the system dynamics. These insights lay the foundation for participants to propose potential solutions while better accounting for their respective constraints.

Co-designing solutions and discussing their feasibility

Participants proposed solutions for farmers to use safer water and discussed their feasibility based on their respective experiences and perspectives. The GWCL representative advised

farmers to drill boreholes for groundwater, but concerns arose over salinity risk and high upfront costs. Participants noted landowners are hesitant to allow drilling, fearing installing permanent infrastructure may grant farmers land rights. A farmer claimed that even if his landowner agreed to a borehole, and he managed to secure the investment and treat the salinity, “When, tomorrow, one big man comes for the land, where am I taking the borehole? He’s the one who is going to benefit!”

Land tenure insecurity hinders farmers’ opportunity and motivation to invest in equipment that would make irrigation safer, as a director of MMDA’s Department of Agriculture pointed out:

> The land for farming within Accra ... on paper, there's a green belt. On the ground, there's no green belt; it's gone. And so, my farmers understand they don't have the land anymore ... We look at ways of intensifying productivity per unit area so that they can still get something out of it for their livelihoods. They don't invest beyond that. Irrigation, they'll buy pumping machines, they'll buy sprinklers [spray tubes] because you can roll it up and take it away. They will not dig a borehole because it is expensive, and tomorrow the landowner will come for their land.

Urban farmers cultivate mostly undeveloped public or customary land, typically under power lines and near railway tracks and surface water (40). Families with traditional authority own most of the land, while MMDAs regulate its use (41). A Land Use and Spatial Planning Authority (LUSPA) representative and a University of Ghana researcher noted that a 2020 law supports MMDAs in preventing unauthorised land-use changes. However, outdated plans, land speculation, financial interests, and miscommunication hinder enforcement, leading to rezoning de facto floodable open spaces near streams into residential areas (41).

A participant proposed a piped network could supply raw water to farmers, as in other countries. However, others responded that laying pipes is costly and fixing the existing treated water network should be prioritised. Some suggested rainwater harvesting, but the cost and space for storage between the two rainy seasons could be prohibitive. Representatives of the Departments of Agriculture indicated that they favour backyard and school gardening, where there is better access to land and piped water, to address the demand for safer vegetables from households and schools. MoFA's Women in Agricultural Development (WIAD) directorate develops educational material for this purpose.

Another participant suggested subsidising piped water for irrigation:

> If we have to look at some social protection measures, we can redirect it to maybe reducing the tariffs on these farmers who use potable water, and then we can pick it from there [… but if the rates are high, then vices will just creep in, and we won't win.

Some participants suggested GWCL provide an affordable tariff for farmers, as it does for other businesses:

> Ghana Water Company must just change their policy. Ghana Water can go to parliament and PURC [the Public Utility Regulatory Commission] and say it's about time we provide water for irrigation for our own safety and well-being ... And water and sewage must be up and running. It's about time!

Interestingly, this is a rare instance in which participants acknowledged ineffective sanitation. During formative interviews, most representatives outside of agriculture blamed farmers for using contaminated water rather than questioning why the water had become so polluted.

The role of the Public Utility Regulatory Commission (PURC) is to rule on GWCL's proposed new tariff structure and customer categories. PURC ratified moving from the *commercial* to the newly created *non-residential* rate for any "small and medium scale non-domestic customers that use water for drinking and sanitary purposes only, including churches, mosques, faith-based organisations, registered non-profit organisations, schools, hospitals, barbering shops, welding, carpentry and allied businesses, water sellers, shops and offices including firms and retailers" (PURC website, n.d.). PURC then redefined *commercial* customers as "entities and businesses that use water as a significant input in their operations other than for drinking and sanitary purposes such as hotels, restaurants, chop bars, fuel stations, airports, financial institutions, washing bays, laundries, block factories, hair and beauty salons and public toilets" (PURC website, n.d.). Finally, PURC approved a smaller increase for non-residential customers than requested by GWCL, while exceeding GWCL's request for commercial customers. PURC's consideration that water is not a significant input for water sellers and that public toilets do not use water for "sanitary purposes", denotes the flexibility of the categorisation. These arrangements arguably aim to shield domestic customers and small businesses from the major tariff increase, while relying on more affluent customer categories to improve GWCL's cost recovery.

Keeping urban farmers in the commercial category does not substantially help GWCL's cost recovery but thwarts the Departments of Agriculture and Health's efforts to improve hygiene and food safety. While the government subsidises seeds and fertilisers to support the agricultural sector (43), the water tariff is a bottleneck for urban agriculture and food safety, raising public health risks. Moreover, GWCL disincentivising the use of safe water for non-drinking purposes arguably contradicts its mission to meet urban customer demand and

protect health and safety (44). Conversely, applying an affordable rate would reduce the number of unpaid bills by farmers and illegal connections, motivate more farmers to adopt piped water, increase GWCL revenue, and improve hygiene and food safety.

A MoFA representative suggested involving the Ghana Irrigation Development Authority (GIDA) to share their experience with GWCL regarding farmers paying for irrigation water:

> The Ghana Irrigation Development Authority ... has a way where farmers pay for irrigation service charges ... They pay for fuel to draw water from the source ... So, I think GIDA and the Ghana Water Company should [have] a high-level discussion so that the two of them will see how GIDA does that for farmers ... and replicate the same treatment down to the farmers, as far as Ghana Water Company is concerned.

GIDA was not invited to the dialogue because, during formative interviews, its representative stated that urban irrigated agriculture fell outside its scope. The representative cited the institution's lack of regulatory power, especially over informal practices. However, GIDA's experience could help GWCL work with urban farmers. Another MoFA representative noted GIDA's collaboration with traditional authorities to secure land tenure, which could assist the Municipalities in supporting urban farmers and increasing food sovereignty and safety.

GWCL's customer categorisation, MMDAs' lack of enforcement of land use regulation, and GIDA's disengagement raise the question of institutions' own capabilities, opportunities and motivations to play their part in enabling the adoption of safe practices that improve food safety and public health. GWCL and PURC may not have the motivation to apply the "non-residential" rate to urban farmers. If this is the case, then MoFA may not have the opportunity to bring the matter to parliament, nor have the motivation to develop a strategy

to support safer urban irrigated agriculture, nor the knowledge and skills specific to urban agriculture. Consequently, municipalities may not have the motivation and capabilities to enforce land-use regulations, or allocate adequate resources to allow Departments of Agriculture to support urban agriculture. A Director of a Department of Agriculture explained: "When I went to the Municipal Assembly the first time, the budget officer didn't want to listen to anything agriculture". Another added:

> The challenge is that the voice of agriculture is not too strong, and it is not too valued or recognised. Because we as a nation talk agriculture [but] we don't have agriculture in our hearts, we don't have agriculture in our minds. Even though we say we are an agricultural country, it's just on paper ... Our money doesn't go into agriculture.

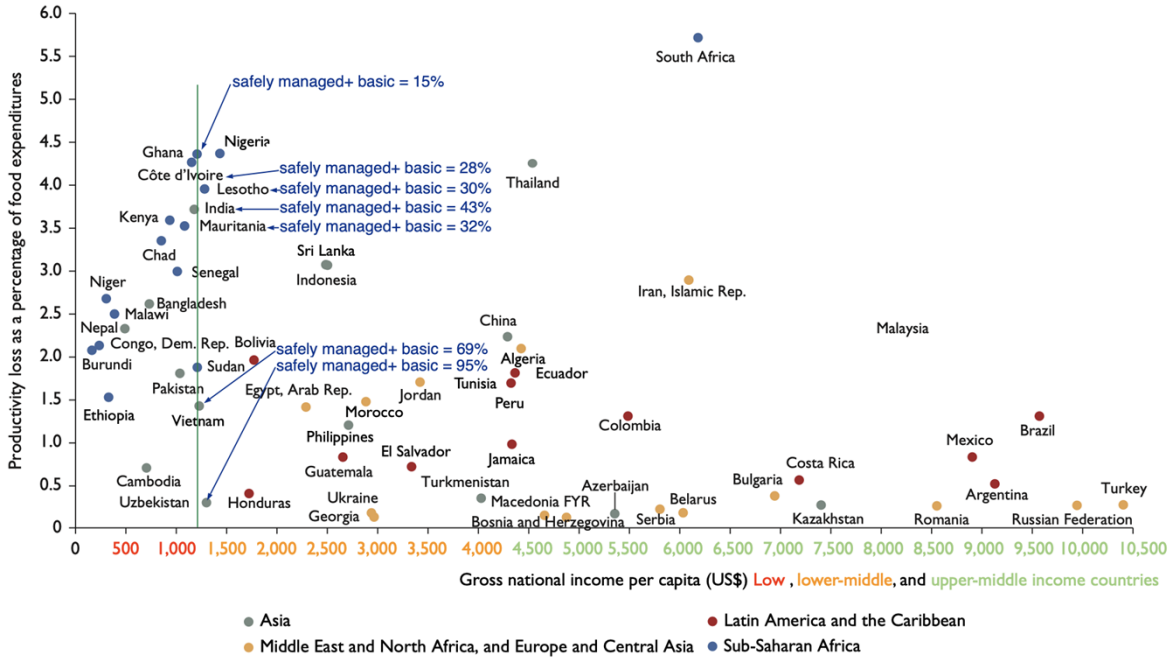
Another participant gave an example:

> You go to a farm today, tomorrow … there's a structure there ... Everybody wants to [buy] land, and they are paying hundreds of thousands of dollars for the land. So, the farmers are being pushed out ... On paper, there's a green belt [in Accra] where the land is supposed to be left for farmers to enhance the greenery, but everything is built up, and it's high-level top politicians and big management people who sit in parliament and make those decisions not implementable.

As a MoFA representative put it:

> It means we have to act together. … So I think we'll have to take this to another level where we can also bring up options if people are using this [water] for irrigating vegetables within the urban space ... to safeguard the health of the consumer; it's very crucial.

Similarly to Figure 3, which was presented at the start of the dialogue, the participant translates the health burden from food safety issues into economic terms and shows the dire situation of Ghana compared to other countries with similar gross national income (GNI). The horizontal axis represents the GNI of selected LMICs, while the vertical axis indicates productivity loss from foodborne diseases. A vertical line compares the economic burden with sanitation coverage in countries with similar GNI. In 2010, productivity loss in Ghana was more than twice that of Vietnam and four times that of Uzbekistan; their respective enhanced sanitation coverage was 15%, 69%, and 95%. Translating the health burden from food safety, especially contaminated irrigation water, into economic terms could motivate politicians to develop strategies across the agricultural, health and water sectors at local and national levels.



Source: World Bank calculations.
JMP, Sanitation service levels, national coverage in 2010 (consulted 2024)

Figure 3 Relative Burden of Foodborne Disease, by per Capita Income, 2010 (adapted from Jaffee et al., 2019, p. 42)

A lack of sectoral coordination limits food safety promoters to targeting potential small improvements by focusing on quick, in-depth changes, such as stakeholder practices. Small gains are essential to securing farmers' commitment. However, changing practices without changing the environment that generated them is labour- and cost-intensive for farmers, challenging to sustain and monitor, and unlikely to improve food safety and public health at the municipal scale. System-wide attempts to make changes easier in practice require coordination at a high level (45,46).

Achievements, potential and limitations of the process

The multistakeholder dialogue successfully engaged a broad range of participants in collective learning. The COM-B framework and Companion Modelling approach allowed participants to specify underlying issues not previously addressed. These insights, along with the feedback from participants, enriched everyone's understanding of the institutional factors hindering farmers' capability, opportunity, and motivation to adopt safe practices.

Extending this systematic and comprehensive analysis to the entire value chain requires opening the dialogue to the "extended peer community consisting of all those with a stake in the dialogue on the issue" (47). Participants suggested involving institutions that had not initially been considered or identified. The dialogue occurred during office hours, which was convenient for institutional representatives and manageable for farmers but conflicted with the daily activities of vegetable traders and street food vendors, who were unable to participate. Moreover, Companion Modelling is an iterative and time-consuming process which may require more time than participants are willing or able to allocate, thus perpetuating a status quo where the most vulnerable groups are not heard (48).

Some institutions were reluctant to engage in the process, delegating representatives who acknowledged being uninformed about the topic or working in a position irrelevant to the matter. None of the participants positioned themselves as decision-makers. Executives are less able to find time to engage in collective learning and may be more interested in preserving their position, resulting in a disconnect between knowledge and decision-making powers (49). While this limited the immediate impact of the first iteration, over time, further multi-stakeholder dialogue could bridge this gap. Participants would need to comprise a balanced mix of executives, managers and experts (including stakeholder representatives), with interactions regular enough to foster trust and reciprocity to enable brokering knowledge and policy-making (49).

The multistakeholder dialogue illustrated how stakeholders' adoption of safe practices depends on institutions' own capabilities, opportunities and, particularly, their motivations. Participants call for the urgent prioritisation of hygiene and food safety in local bylaws and national policymaking, raising the question of the political will (i.e. institutions' motivations) and its influence on institutional capabilities and opportunities. Developing narratives that connect the dialogue with institutions' value systems could motivate executives to engage or delegate representatives with decision-making powers (50,51). For example, while food safety along the vegetable value chain may not be at the core of GWCL priorities, and they may push against farmers' use of piped water for irrigation, they might engage in a dialogue that gives them the opportunity to increase their cost recovery from farmers. Neoliberal shifts often lead to a marginalisation of urban agriculture, which is then perceived as a practice that does not belong in the modern city (52,53). Since so many urban dwellers depend on urban agriculture for their livelihoods and access to a nutritious diet, it is paramount to secure

strong political will at the highest level to integrate urban agriculture into urban planning for more sustainable and safer outcomes.

Further steps include simulating current and prospective practices and arrangements, comparing outcomes, and assessing necessary adaptations from stakeholders and institutions. Participants could then select the combination of safe practices most suited to their context and co-design arrangements that enable adoption by accounting for both stakeholders' and institutions' capabilities, opportunities and motivations.

Conclusion

The multistakeholder dialogue brought actors around the table who rarely meet. It clarified for all participants the misalignment between institutions' strategies and farmers' realities. To enhance hygiene and food safety, Departments of Agriculture and Health seek to motivate farmers to use piped water for irrigation. However, to improve cost recovery, the water utility implements tariffs that restrict farmers' opportunity to use piped water. Moreover, the municipalities' failure to enforce land use regulations limits farmers' opportunities and motivation to secure alternative safe water resources. These institutional barriers threaten farmers' livelihoods, undermine food safety and perpetuate public health risks. Participants suggest collaboration between the water utility, the regulatory authority, the irrigation authority, and their respective parent ministries to offer farmers an affordable rate.

Such open discussion allows participants to diagnose stakeholders' capability, opportunity, and motivation needs more extensively than interviews. Combining the COM-B framework with the Companion Modelling participatory approach enables participants to bridge

knowledge gaps caused by sectoral silos and top-down approaches, broadening discussion beyond generic needs for education and training, incentives and sanctions. Together, stakeholders can identify actors, resources and interactions previously overlooked, leading to participants developing a shared understanding of each other's perspectives. The dialogue makes explicit how institutions' objectives and constraints may hinder stakeholders' opportunity and motivation to adopt safe practices. Such open discussion lays the foundation for co-designing arrangements that better account for stakeholders' and institutions' capabilities, opportunities and motivations.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

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Data availability

Data will be made available on request.

Authors contributions

	Conceptualisation	Methodology	Supervision	Investigation	Facilitation	Formal analysis	Validation	Visualisation	Writing - Original draft	Writing – review and editing
DG	X	X		X	X	X	X	X	X	X
RS	X	X	X							X
KG	X	X	X							X
PA					X		X			X

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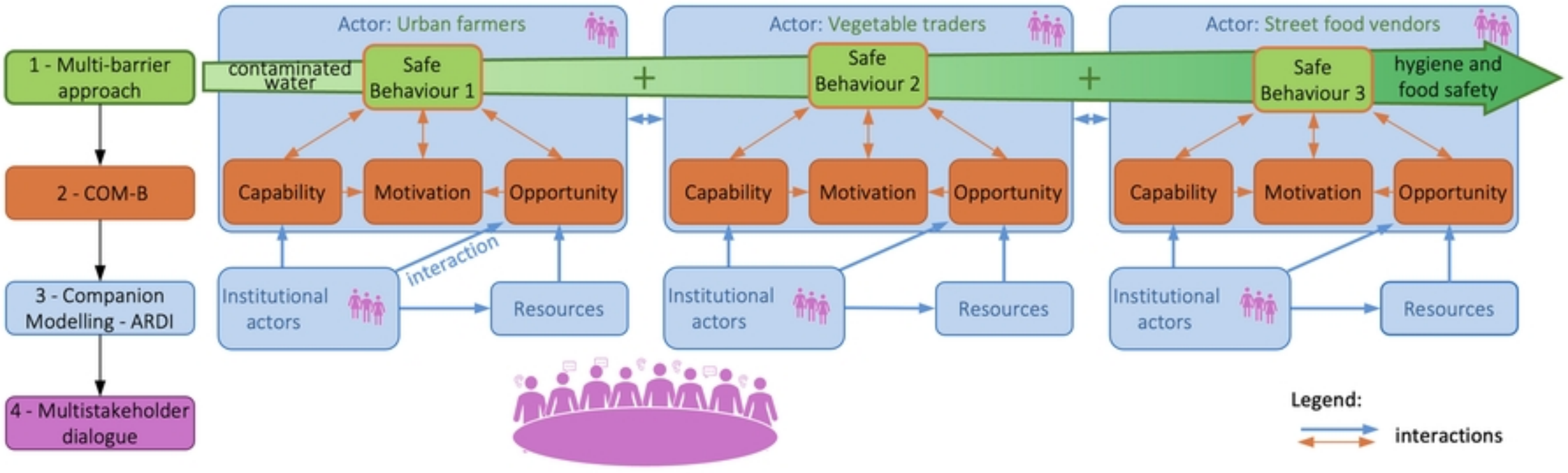

1 - Multi-barrier approach
2 - COM-B
3 - Companion Modelling - ARDI
4 - Multistakeholder dialogue
Actor: Urban farmers
Actor: Vegetable traders
Actor: Street food vendors
contaminated water
Safe Behaviour 1
Safe Behaviour 2
Safe Behaviour 3
hygiene and food safety
Capability
Motivation
Opportunity
interaction
Institutional actors
Resources
Legend:
interactions

Figure 1

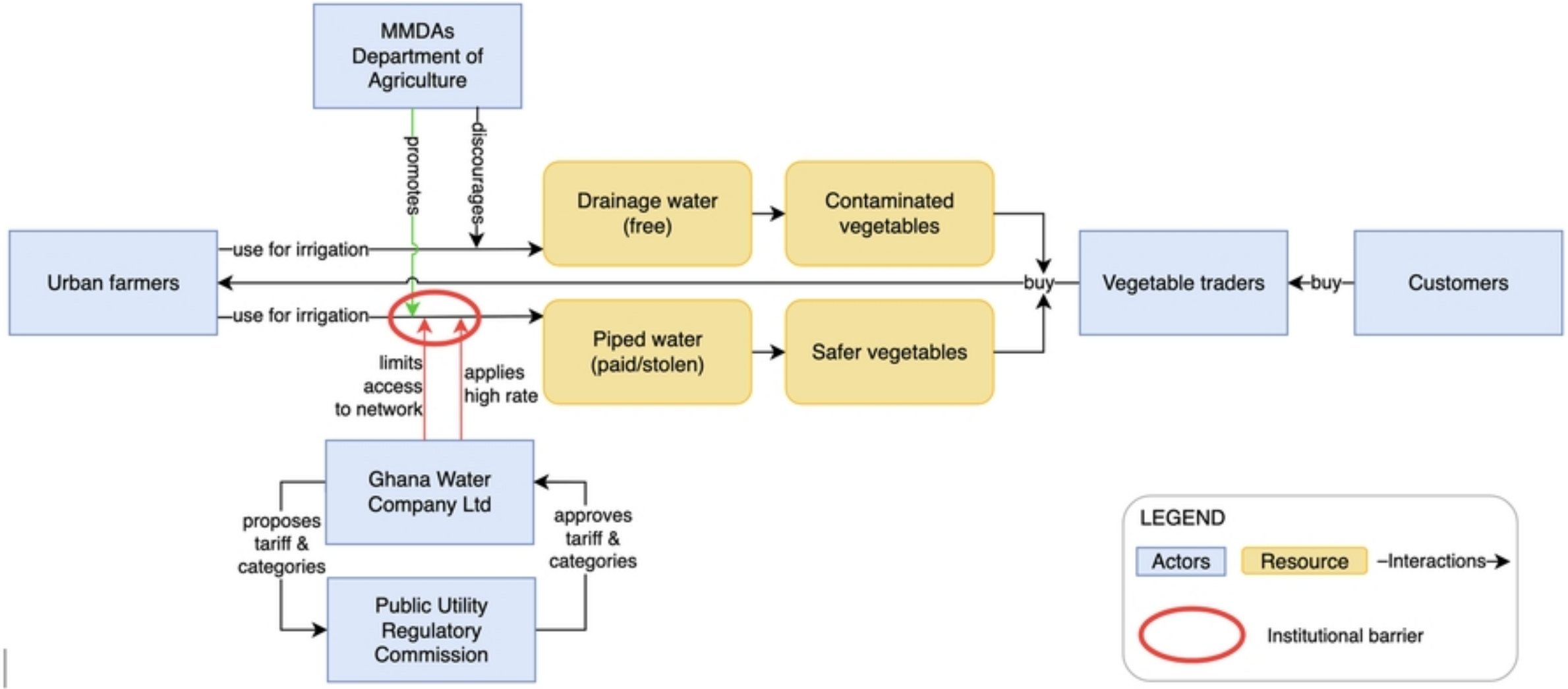
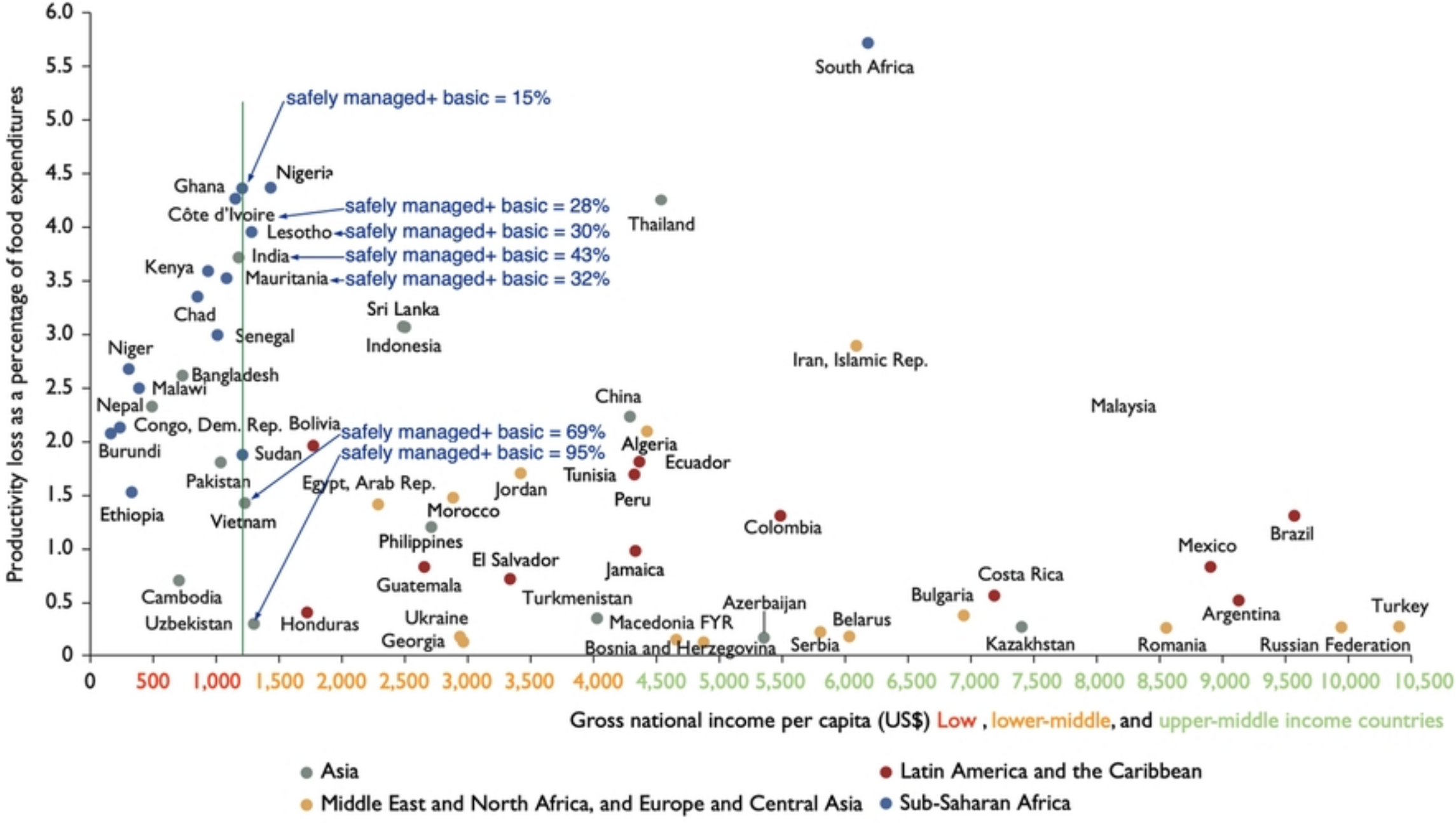

MMDAs Department of Agriculture
promotes
discourages
Drainage water (free)
Contaminated vegetables
Urban farmers
use for irrigation
use for irrigation
buy
Vegetable traders
buy
Customers
Piped water (paid/stolen)
Safer vegetables
limits access to network
applies high rate
Ghana Water Company Ltd
proposes tariff & categories
approves tariff & categories
Public Utility Regulatory Commission
LEGEND
Actors
Resource
Interactions
Institutional barrier

Figure 2



Source: World Bank calculations.

JMP, Sanitation service levels, national coverage in 2010 (consulted 2024)

Figure 3