frontiers | Frontiers in Sustainable Food Systems

TYPE Original Research
PUBLISHED 07 November 2022
DOI 10.3389/fsufs.2022.724190

OPEN ACCESS

EDITED BY
Rachel Bezner Kerr,
Cornell University, United States

REVIEWED BY
Jiping Sheng,
Renmin University of China, China
Lewis Abedi Asante,
Kumasi Polytechnic, Ghana

*CORRESPONDENCE
Sandra Boatemaa Kushitor
boatemaa@sun.ac.za

SPECIALTY SECTION
This article was submitted to Social Movements, Institutions and Governance, a section of the journal Frontiers in Sustainable Food Systems

RECEIVED 12 June 2021
ACCEPTED 05 October 2022
PUBLISHED 07 November 2022

CITATION
Kushitor SB, Badu M, Kushitor MK and Currie P (2022) "Working with little:" Access to market infrastructure and its effect on food handling and food safety among vegetable traders in an African city.
Front. Sustain. Food Syst. 6:724190.
doi: 10.3389/fsufs.2022.724190

"Working with little:" Access to market infrastructure and its effect on food handling and food safety among vegetable traders in an African city

Sandra Boatemaa Kushitor[1,2]*, Mercy Badu[3], Mawuli Komla Kushitor[4] and Paul Currie[5]

[1]Food Security Initiative and Centre for Sustainability Transitions, Stellenbosch University, Stellenbosch, South Africa, [2]Department of Community Health, Ensign Global College, Kpong, Ghana, [3]Department of Chemistry, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana, [4]Department of Health Policy Planning and Management, School of Public Health, University of Health and Allied Sciences, Hohoe, Ghana, [5]ICLEI Africa, Cape Town, South Africa

Despite the crucial role played by informal markets in food distribution globally, the sector is ignored and marginalized. This study examined vegetable traders, the trading infrastructure available to them in the market, and how they conduct their businesses to explain the high food safety challenges in the sector. This paper is based on a survey, a learning journey, and transformation labs with market traders in Kumasi, Ghana. The study revealed that most traders were self-employed women with low education who worked for long hours. Access to electricity, water, refrigerators, and storage facilities was limited in the market. Vegetable spoilage was the highest cost associated with their trade. Due to the high spoilage rate, the traders sold the best vegetables at high prices and sold the bruised and rotten vegetables to local eateries and animal farms. The women made no losses through these strategies but used unsafe food handling practices and highly-priced wholesome vegetables. Their actions can reduce urban food security, especially in low-income households. Access to market infrastructure was influenced by availability, power and cost. Vegetable trading was the predominant livelihood of the traders. To improve the efficiency of the sector, efforts can be made toward the provision of services at the markets, and advocacy of the traders about food security implications of their actions by the municipal assemblies and market leaders.

KEYWORDS

urban food distribution, traditional markets, vegetable trading, Kumasi, informal traders, Ghana

Introduction

Food safety and food security are critical components of food systems with implications for population health (Walls et al., 2019). Food safety and food security are influenced by how food is produced, accessed and consumed (Wilson and Worosz, 2014; Boatemaa et al., 2019). Food security is influenced more by access than production in

urban areas since about 80% of food products are acquired from the market (Middleton, 2016; Tuholske et al., 2020). The informal food market is primarily the nerve center of food distribution and access and contributes significantly to urban household food safety and security (Battersby et al., 2016; Tete Larbi et al., 2021). Therefore, a thorough understanding of urban food systems must include informal food vendors, the challenges of the sector, and their contribution to the food and nutrition needs of present and future generations (Balineau et al., 2021).

In Africa, the informal market drives the entire food system, connecting small and medium-scale farmers to markets in cities (Goodfellow, 2018; Asante and Helbrecht, 2019). The informal market receives supplies from several rural markets through a chain of vastly interconnected intermediaries. This intricately complicated urban space with little formal regulation controls the handling, storing, preserving, and sale of a variety of fresh, cooked, and delicate food items (Tomlins et al., 2002; Bhattacharya and Reang, 2014; Omari and Frempong, 2016). However, little is known about how market traders undertake these complex processes with scarce resources and often limited logistics. Despite their contributions to urban food distribution, the informal market is often perceived as chaotic, unhygienic, inefficient, and outdated. Informal traders are usually ignored or marginalized by city policies (Asiedu and Agyei-Mensah, 2008; Anyidoho and Steel, 2016). These unfortunate perspectives associated with the informal African market are a derivative of years of neglect, spontaneous growth, and often little regulation (Resnisck, 2017; Kazembe et al., 2019).

Traditional market spaces are common across African societies (Clark, 2010; Ikioda, 2013). Research on the physical attributes of market spaces has described the market's origin and its positionality within the urban area (Ikioda, 2013). Most of the reports show limited access to physical market infrastructure and associated environmental degradation. For example, on market days, the conflict of space by users due to the influx of drivers, vendors and buyers without an organized traffic management system contributes to traffic congestions, decreased sales and stress (Agyapong and Ojo, 2018). Limited access to waste disposal services has created a significant challenge to maintaining and sustaining hygiene within markets. The implications of such are food safety compromises and the spread of infectious diseases associated with such spaces and vendors (Rheinländer et al., 2008; Omari and Frempong, 2016; Tete Larbi et al., 2021).

In an attempt to improve market infrastructure, some governments in Ghana have attempted to regenerate and modernize old and dilapidated market structures (Asante and Helbrecht, 2020). These renovations include the construction of drainage systems, market shelves and washrooms. However, the scale of these renovations does not meet the demand for services by traders and vendors. In addition, research on how traders adapt to their market infrastructure and how this affects food handling, safety and security is limited. Using mixed methods approach, this study examined vegetable traders, the trading infrastructure available to them in the market, how they conduct their business, and how these factors affect vegetable handling, safety and waste. The findings provide evidence on improving food distribution in cities and informing global and national activities toward redesigning food systems to meet the UN Decade of Action on Nutrition 2016-2025 led by the WHO the FAO. In addition, through the provision of social and economic benefits, sustainable informal food systems contribute to achieving poverty eradication (SDG 1), zero hunger (SDG 2), full employment and decent work for all (SDG 8) and reducing inequalities (SDG 10).

Governance and infrastructure development of market places in Ghana

The importance of marketplaces in Ghana and most West African countries have been characterized with the role they play in the growth of urbanization. The District Assemblies (DAs) are responsible for the establishment and administration of market centers in the country, according to the Local Government Act 462, 1993. The DAs are tasked with foreseeing the daily administration of the markets, with the support of elected market queens (referred to as Ahemma). A market queen is selected on attributes like age, financial independence, conflict management, and resolution skills, and one's familiarity with market affairs (Owusu and Lund, 2004). The market queen is also the head of the various goods and services traders' associations. There are informal and oral rules set by the traders' associations that govern the daily behavior and actions of traders. In the Konkomba Yam market situated at Accra, there are traditional leaders which includes the Konkomba Chief of Accra, who participate in governance and receive tributes in kind from traders in return for influencing city authorities for improvements and inclusion in the decision making process (Stacey et al., 2021).

The needs and problems of traders are first reported to the market association and revenue collectors from the DA, who in turn present them to the Assembly. However, the role these trader association play in influencing the DAs are limited (Owusu and Lund, 2004). The limited power of market managers was seen clearly in the redevelopment of the Kotokuraba Market in Cape Coast. It was expected that the leaders in the markets would be engaged during the construction phase, however, this was not the case (Asante, 2020). Recently, the government has invested funds into market renovations and upgrading. The aim of these renovations is to modernize markets for economic growth and development. Unfortunately, these renovations have been hindered by financial challenges due to the inability of the government to raise both local and international funds (Lartey, 2021). This has stalled several

TABLE 1 Research methods and target social groups and social spaces.

Method (s)	Social group; social spaces (Number where applicable)	Data and method of analysis
Quantitative survey	5 markets in Kumasi and 1 in Ejisu; Surveyed tomatoes and cocoyam leaves trader ($n = 376$)	Descriptive statistics: frequency, means and cross-tabulation
Learning journey	Ten research team members observed activities at Ejisu and Ayigya markets led by city officials	Field notes: thematic analysis
Transformation labs	T-labs with tomatoes and cocoyam leaves traders from two markets ($n = 37$)	Workshop report and transcript of voice files: thematic analysis

projects and prevented traders from using the facilities. Another challenge with the markets, is the lack of regular maintenance which results in breakages and destruction of existing and new facilities (MyNews, 2022).

Materials and methods

The study area

This study was conducted in the Kumasi Metropolitan Assembly and Ejisu Municipal Assembly. Kumasi is the second-largest city in Ghana (GSS, 2019) and close to it is a typical farming municipality (Ejisu). Kumasi is a traditional trading city. The city has several markets, including the largest informal market in West Africa called the Kejetia market. The Kejetia market is a trading hub for Cote D'Ivoire, Togo, and Niger. Different vendors trade in these markets, providing a range of goods and services, including the sale of agricultural produce, processed foods, electronics and telecommunication, and others. The markets consist of stalls and open space trading spots. Women are the dominant traders in these markets (Clark, 1994). City authorities and market trading associations manage the markets. The market queen heads the market trading associations with the support of the commodity trading association market queens. All the commodity-specific market queens are in charge of their subordinate traders.

Even though Kumasi is a food hub, there is low consumption of fruits and vegetables, similar to what has been reported in other cities in Ghana (Amo-Adjei and Kumi-Kyereme, 2014). Dietary intake in Kumasi usually consists of a staple and sauce meal, with the most common being *fufu* (cassava and plantain pudding), and *ampesi* (boiled yam or plantain). Tomatoes and cocoyam leaves constitute essential ingredients of these Ghanaian staple foods (Frank et al., 2015). While tomatoes are used in almost all sauces/stews in Ghana, cocoyam leaves are used to prepare *abom* served with the *ampesi*.

Study design

This study is part of a broader transdisciplinary study of informal food vendors in Cape Town, South Africa and Kumasi, Ghana by the Food Security Initiative at Stellenbosch University, the Department of Chemistry at the Kwame Nkrumah University of Science and Technology (KNUST) and Iclei Africa through the Inclusive Metabolism project (Kushitor et al., 2020). The Inclusive Metabolism project examines how informal infrastructure facilitate service provision in cities. The project explores theories and practices of urban food flows, applying a critical metabolic lens to the whole food system. The International Science Council provided funding for the project through the LIRA Africa 2030 program. This paper uses mixed methods and presents data from a trader survey, a learning journey, and a transformation labs (T-labs) (Table 1). The results of the three data sources were triangulated and merged to tell a single story.

The methods were mixed sequentially. At inception meetings, several discussions were held between the research team, city authorities, and leaders of the various markets. These inception meetings provided the background to foray into the market process. This was followed by market visits by the research team to familiarize themselves with the markets. Based on these engagements, the appropriate sampling frames were developed from the information provided by the various commodity market queens. The survey findings were again communicated to the women for validation and appropriateness in T-lab workshops. Engagements from the T-lab were recorded with permission from the study participants. The participants provided explanations to the observations reported in the survey findings during the T-lab sessions. A learning journey was conducted before the T-labs. The aim of the learning journey was to facilitate interactions and explorations of the markets to identify challenges and opportunities for addressing such. The mixing of data types was to validate the survey findings (Olsen, 2004). Table 1 provides the breakdown of methods by their analytical procedures.

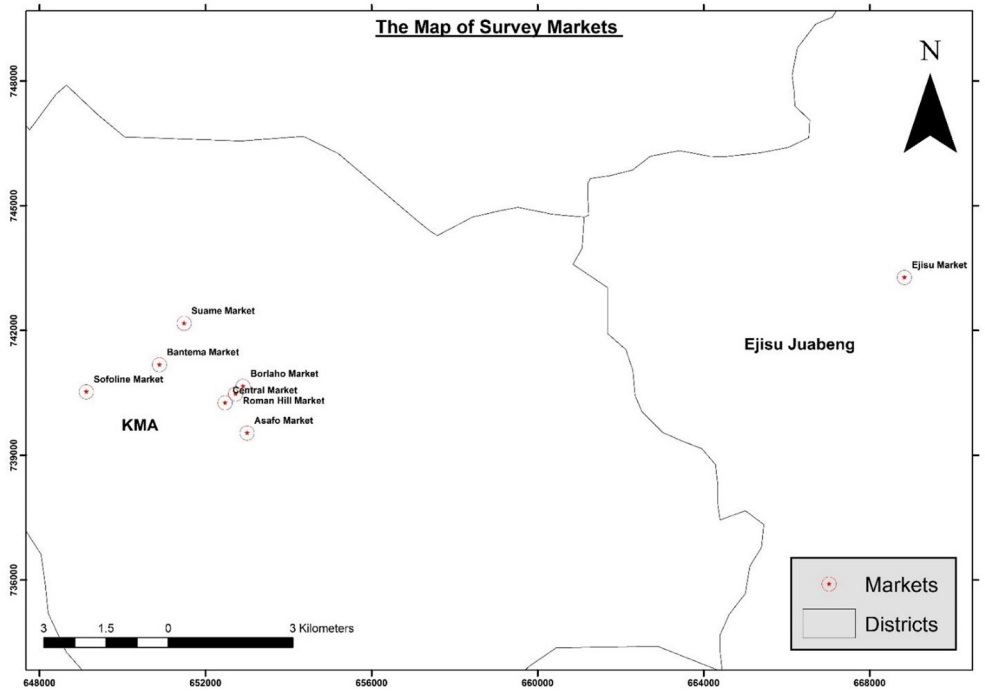

FIGURE 1
The map of the markets surveyed.

Quantitative data collection and analysis

This study surveyed vegetable traders in the Kumasi Metropolitan Area and one of Ghana's most prominent farmer's markets, Ejisu market. Based on co-production meetings with city authorities, we selected six of the most important markets for the distribution of vegetables. The selected markets were Asafo, Bantama, Ejisu, Kejetia, Sofoline, and Suame (Figure 1). The sampling frame for the survey was undertaken from the list provided by the tomato and cocoyam leaves commodity queens in all six markets. When convenient for the women, interviews were carried out by trained research assistants from the Kwame Nkrumah University of Science and Technology. The research assistants had competency in the Twi language, which was the preferred language of the interview.

The study adapted the survey instrument designed by the Consuming Urban Poverty Project at the University of Cape Town (Fuseini and Sichone, 2018). The project aimed to examine the governance of food systems in secondary African cities to facilitate poverty alleviation (Fuseini et al., 2018). Co-production meetings were held with market coordinating councils to review the instrument for cultural appropriateness. Precisely, the questionnaires captured information on socio-demographic characteristics (age, level of education), employment details, business structure, vegetable sourcing, and handling. This study used means, standard deviations, and percentages to describe the variables.

Learning journey

A learning journey is a learning experience designed to enhance the learning experience of students in the field of education (Wilder and Lillvist, 2018). The goal of developing learning journeys is to allow teachers to put themselves in learners' shoes to understand better the learners' needs, perceptions, and emotions WBT Systems. (2021). Learning journeys facilitate conversation and insights about needs, pain, and opportunities for improvement. In the context of research, learning journeys have been described as a way of exposing a group of people (who are united in their interest in a particular issue but diverse in their positions and perspectives on that issue) to the current realities, experiences and stories of people most directly affected by that issue (Southern Africa FoodLab., 2021, p. 7). Learning journeys are expected to provide an entry point into a deeper understanding of the realities of the issues of interest and provoke discussions about how to address these realities. Learning journeys have been used across various contexts, including workplace and community observations (Greaves et al., 2012). In South Africa, the Southern Africa Food Lab has facilitated learning journeys of food systems

transformations in Johannesburg, Cape Town and other towns (Southern Africa FoodLab., 2019).

We adapted the food system learning journey developed by the Southern Africa FoodLab. The research team led by the officers from the municipality went to the markets to observe specific infrastructures such as trading spots, goods display, and availability of toilets, electricity, and water (learning objects). The visits were set up to provide an opportunity for cross learning between the research team, market women and municipal officers. For this study, two sets of learning journeys were conducted. The first was before the survey, and the second was after the data collection in preparation for the T-lab. Debriefing sessions were organized after each learning journey to reflect on the observations and to discuss steps forward. Notes were collated into a single document.

Transformation-lab with traders

Transformation lab (T-lab) is a facilitation approach that enables dialogue, sense-making, reflection, and reflexive learning, while supporting the reframing of issues in ways that allow solutions—or attempts to experiment and transform—to be co-created and co-realize. The goal of T-labs is to foster mutual learning and reflections about topics that matter to the participants. T-labs are designed to be people and context-specific. In South Africa, a set of T-labs has been conducted to discuss food system transformations with alternative food system actors and coastal wild food actors (Zgambo et al., 2018; Cramer et al., 2019). SBK was involved in the planning and facilitation of these T-labs, and MKK was a participant observer at one of the T-labs.

The objective of this T-lab was to have a conversation with the traders about their livelihood activities and find innovative ways of addressing their challenges. The T-lab was conducted in Ejisu and Oforikrom Municipalities. The T-lab was designed in four sections. The participants were asked to introduce themselves by describing their passions about food and how their passions influence their market activities. The introductions were followed by a presentation of the survey findings, with questions and answers. This was followed by a photo exhibition of food distribution in African cities. The pictures were selected from a collection of photos prepared by urban residents and professional photographers about resources in Africa cities called Hidden Flows. The Inclusive Metabolism project created hidden Flows in African Cities (see the exhibition here: https://www.thenatureofcities.com/hidden-flows-rise-africa/). The photos were used to facilitate photo-voice discussions related to market activities and processes. Three T-labs were held on two working days (November 18 and 19th Nov. 2020). Key participants of the T-lab were vegetable traders from two markets in the Ejisu ($n = 17$) and Oforikrom municipalities ($n = 20$) selected by the commodity queen mothers. The market queen mothers were also in attendance. The sessions were recorded, and the research team took field notes.

Ethics

The study protocol was reviewed and approved by the Ethics Review Committee at KNUST. Written informed consent was sought from each respondent before the commencement of the interviews. In compliance with COVID-19 safety protocols, all participants were provided with face masks. Also, participants were required to wash their hands before entering the venue. They were also provided with alcohol-based hand sanitisers before and after the workshop. Participants were significantly distanced in their seating arrangements by following the 6-meter spacing protocol of the Ghana Health Service.

Results

Socio-demographic characteristics and business information of vegetable traders

The survey recruited 376 traders. Two hundred and sixty were tomato sellers, and 116 were cocoyam leaves traders (Table 2). The majority of the traders were female (95%). For both tomatoes and cocoyam leaves, only 12 out of a total 376 people recruited were men. This may not truly reflect the ratio of men to women in the market place given that gender dynamics influence the trading product in the marketplace. For example, the story might have been different if the study was conducted amongst meat traders since men dominate meat trading. Traders with Junior High School education constituted the largest educational block of the vendors (50%). The women perceived the market as the only means of legitimate means of employment as indicated by the following quote:

> *"Our low educational background makes us not well resourced to work in offices. Therefore, selling food items provides the best opportunity for us as women"* (Ejisu, T-lab).

About one-fifth of the traders were from the Asafo (19%), Ejisu (20%), and Sofoline (22%) markets. The majority of the women owned their business (93%), and about half had traded for more than 10 years (52%). The women worked for long hours, about 11 h on average. Most start their trade between 4 and 6 am (73%) and close at about 3 pm-6 pm (57%). Almost all the women traded at approved zones at the market (90%). The approved zones included sheds and spots on the floor. Some

TABLE 2 Background characteristics of respondents.

Variables	Frequency	%
Type of trader		
Tomato trader	260	30.8
Cocoyam leaves trader	116	69.2
Sex		
Male	19	5.1
Female	357	94.9
Trader's age		
20–29 years	30	8.0
30–39 years	82	21.8
40–49 years	132	35.1
50–59 years	94	25.0
60+ years	38	10.1
Level of education		
No education	62	16.5
Primary	87	23.2
Junior High School	187	49.7
Senior High School and above	40	10.6
Market of traders		
Asafo	77	20.5
Bantama	73	19.4
Ejisu	23	6.1
Kejetia	21	5.6
Sofoline	99	26.3
Suame	83	22.1
Total	376	100

of the trading spots of the women were inherited from their mothers as reported below:

> "*My mother sold food for several years in the market where I used to visit and help her to sell. My continuous visit to the market made me love selling food at the market as my mother made several friends and networks by working in the market. I took over her trading spot.*" (Ayigya, T-lab).

From the learning journey, it was observed that most of the trading in the markets spilled over into adjoining bus stations. Some vendors traded at the intersection between the market gate and the main street causing heavy traffic and discomfort to motorists and pedestrians alike. It was common for women to sell vegetables in the open sun, as that was the only space available to sell to some traders. Selling under these difficult circumstances had implications for both traders and the quality of vegetables sold. Most of the women traded in the market without a license. About 75% of traders believed they required no license to trade. Only 2% had been given the permit to trade from the municipal assemblies (Table 3).

TABLE 3 Business information of tomatoes and cocoyam leaves traders at six markets in Kumasi.

Variable	Frequency	%
Ownership of business		
Owner	349	92.8
Operator	27	7.2
Years of business operation		
Less than a year	8	2.1
1–2 years	31	8.2
3–5 years	69	18.4
6–10 years	72	19.2
>10 years	196	52.1
Opening hours		
2–4 am	36	9.6
5–7 am	291	77.4
8–9 am	26	6.9
No specific time	23	6.1
Closing hours		
12 noon—3 pm	23	6.1
4–6 pm	215	57.2
7–9 pm	102	27.1
After 9 pm	9	2.4
No specific time	27	7.2
Business license		
Have license	9	2.4
No license required	281	74.7
Pay a vending license as a permit	59	15.7
Trade without license	27	7.2
Location of store		
Market non-approved zone	17	4.5
Street edge	19	5.1
Mobile trader	3	0.8
Market approved zone	337	89.6
Profitability of business		
Very profitable	139	36.9
Average	213	56.6
Poor profit	16	4.4
Lose money	8	2.1
Total	**376**	**100**

The bold values are the totals for the sample size frequencies and percentages.

Access to trading infrastructure at the market and its effect on food handling and safety

Most of the traders did not have access to basic amenities at the markets (Table 4). About two out of five had access to

TABLE 4 Type of infrastructure available to traders at the market and major cost associated with their trading in Kumasi.

Variable	Asafo	Bantama	Ejisu	Kejetia	Suame	Sofoline	Total
Type of infrastructure							
Water	39.7	30.4	41.6	61.9	45.8	33.3	40.3
Waste disposal	63.0	47.8	44.2	95.2	83.1	73.7	67.3
Storage	4.1	4.3	3.9	0.0	4.8	11.1	5.8
Electricity	15.1	17.4	36.4	71.4	33.7	14.1	26.6
Refrigerator	0.0	13.0	15.6	9.5	3.6	1.0	5.6
Toilet	83.6	86.9	80.5	100.0	95.2	89.9	88.3
Shade	45.2	56.5	48.1	38.1	33.7	39.4	42.0
Major cost to business apart from stocking							
Spoilage	93.1	82.6	96.1	85.7	83.1	74.7	85.6
Transportation	76.7	39.1	29.9	76.2	68.7	58.6	58.2
Licenses and permits	21.9	0.0	2.6	9.5	19.3	14.1	13.3
Energy	11.0	17.4	18.2	14.3	12.0	6.1	12.0
Debts	27.4	4.3	5.2	28.6	20.5	28.3	20.2
Wages	38.4	17.4	1.3	33.3	26.5	24.2	22.9

piped water (40%). According to the women, without water, they could not clean their vegetables or keep them fresh. From the learning journey, we observed that the market is a busy social space, with lots of human and vehicular traffic, resulting in close contact with goods. Secondly, prospective buyers' touch and feel the products before buying, highlighting the need to wash vegetables constantly.

About two-thirds (67.3%) of the traders had access to waste disposal facilities. According to the women, garbage tanks are often kept at specific locations outside the markets. City authorities periodically emptied these. However, the little challenge was that many traders were unprepared to move out to dispose of their waste. Frequently, the market floors were covered with litter from trading activities as reported by the Ayigya traders:

> *We sweep and gather the waste and then keep them outside until the waste disposal vehicle comes for them around 6 am. The containers are large metallic containers situated outside the market. However, this does not apply to every market woman since the waste disposal service comes at a cost.* (Ayigya T-Lab)

A large proportion of the waste eventually got into the limited drainage facilities on the market floor. It was common to find water stagnating in these drainages because they were choked with rubbish. It often produced a strong smell of rotten vegetables in a few locations. For a system that produced so much waste, waste disposal efforts were mismatched with the sheer quantity of waste generated.

Besides waste, storage was a key individual attribute of women in the market. The survey revealed that only 5.6% of all vegetable traders recruited for this study had any form of secure storage. The shed on the market is often constructed without shelves for storage. Black opaque polythene bags were commonly used to bag vegetables. These black opaque inappropriate polythene bags trap heat and hasten the rate of spoilage. Some women developed makeshift wooden storage facilities in their sheds. Market women stored food items in baskets and bowls wrapped in polythene bags. Traders could also keep their vegetables in refrigerators, but this was uncommon since only 26.6% had access to electricity and 5.6% had refrigerators. A few women could afford stalls designed to store. Only a handful of vegetable traders fell within this category. Although sheds that had built-in secure storage were available, they were not designed for vegetables. These market designs challenge made it difficult for vegetable traders to function well. Due to the lack of secured storage, most traders consistently complained about theft and insecurity in the marketplace.

The major cost associated with vegetable trading

One of the most important and revealing sections of the survey was the most important cost associated with trading vegetables. Aside from stocking, about 86% of all respondents mentioned spoilage as the most important cost item. While

this high reported rate of spoilage was alarming, it was not entirely surprising. Vegetable producers agree that most vegetables have a short shelf life of between 3 days and 2 weeks due to their fragile nature. Market conditions were extreme. Travel duration, handling, and prevailing market conditions were some of the factors associated with the shelf life of vegetables. Vegetable traders had very little control of prevailing market conditions as they mostly did not have the appropriate means nor the space to secure and preserve the vegetables. As reported earlier, less than half (42%) of the traders had a shade over their goods, exposing the products to the direct intensity of the midday tropical sun and increasing the rate of deterioration (Table 3). The women supported these finding with the following quotes:

> *The sun's intensity forces all tomatoes on the market to ripen, creating a glut that drives down profit. (Ejisu T-lab)*
> *Normally, after 3 days, the tomato starts to rot. When you also wash the tomatoes, it deteriorates faster than when you don't wash them. When you bring the tomatoes, they should sell within 3 days. Otherwise, you run into losses. Further, the chemicals used in processing tomatoes for the market contribute to wastage because sometimes they stick to the vegetables even after they are carted to the market. Tomatoes with a visible chemical presence on them wilt faster. We lose a lot of money through spoilage. (Ayigya T-lab)*

Beyond spoilage, the damaging and crushing of vegetables were mentioned at the T-lab. Waste generated from traveling, handling, and crushing vegetables accounted for about a quarter of losses reported by traders. The bruises and the crushing of the vegetables resulting from the manual handling of the vegetables were an important source of waste. First, it reduced the product's visual quality, which is an essential determinant of the market value of the vegetable. Secondly, the bruises create an entry point for pathogens, thus resulting in wilting, yellowing, and vegetable spoilage as explained by the participants:

> *The sale of cocoyam leaves is even more precarious. Once the vegetables did not sell on that same day, they ripened. Many people simply do not like the look of the leaves when they ripen. However, if you need to preserve it, you might store it in a white polythene bag. It can stay for 4 days with that method. Even with this method, it can only be sold between 1 and 3 days. The glory of the leaves departs after a day. (Ejisu T-lab)*

Other important cost items were transportation, licenses, energy, debts, and wages (Table 4). Traders also mentioned licenses where municipal authorities levied some local-level taxes on traders. Some traders described the taxes as menacing as they were required daily before entry was permitted. During the T-labs, the traders mentioned that excessive inorganic chemical fertilizers also caused the rapid deterioration of vegetables. All traders noted that the use of inorganic fertilizers had replaced natural processes for growing vegetables. The traders explained that tomato varieties produced by farmers from Burkina Faso and other places had a much longer shelf life and much better durability compared to those sourced from Ghanaian farmers. They attributed these differences to the application of inorganic chemical fertilizers as noted by the quote below:

> *In the past, farmers grew tomatoes without the use of inorganic agrochemicals. But now, they force the tomatoes with strong chemicals at almost every stage of growth. The chemicals reduce the durability and the shelf life of the tomatoes. Today, tomatoes from Ghana have a very limited shelf life. So I want to use this medium if it is possible to communicate with our farmers to reduce the quantum of inorganic agrochemicals that are currently applied to the tomatoes.* (Ejisu T-lab)

The vegetable supply chain was very manual and rudimentary. Less than 1% of traders received their goods through well-structured formal arrangements. Most vegetables are acquired through middlemen or directly from farmers. Most vegetable vendors had to travel some distance to buy their products and hire labor which is the primary reason for the high cost of transporting the goods as explained below:

> *The transport cost associated with tomatoes comes in bits. For example, you will need people to bag the tomatoes, and you may have to pay them 0.86 US$. Some laborers then offload from the big trucks to safety. You have to pay 1.72 US$ for that. You now have to find smaller vehicles to transport your tomatoes to your local market.* (Ayigya T-lab)

Navigating market infrastructure while pursing profits

According to Clark, market women have a persona of 'shameless persistence in the pursuit of profit' (1999, p. 1). Therefore, we wanted to find out how the women make profit in their business despite the limited resources available to them. In the survey, 37% of the traders reported high profits, while 57% reported average to high profits. According to 20 of the women, they make about 25.77 US$ a week. The market women provided explanations for the way profits were derived despite the high level of waste. According to them, the source of the product determined the timing, sale strategy and price of tomatoes. Market women argued that tomatoes sourced from local Ghanaian farmers had a relatively short shelf life (about 3–5 days), were not

as strong, and wilted faster. The following quotes reflects these views:

> *When the cocoyam deteriorates or shows signs of ripening, it can no longer be sold at the regular market price. We reduce the selling price.* (Ayigya T-lab)
> *One day, I got tomatoes grown by the Agriculture Unit of the University of Science and Technology, Kumasi. I kept the tomatoes for more than 5 days, yet the tomatoes did not show any sign of wilting, wasting, or changing color. It goes to buttress the point that too much use of inorganic agrochemicals substantially weakens the durability of the tomato. Sometimes I buy tomatoes from a local farmer, and by evening I have to discard them. Somehow holes develop in the tomatoes by evening. It is serious!!!* (Ayigya T-lab)

They necessarily had to sell and make their money within those 5 days. The spoilage and wastage resulted from the inability of sellers to provide cold chain storage for their produce. The traders selected the stronger and better-looking tomatoes from the lot for the best price to compensate for the devalued ones. The nearly rotten tomatoes were sold to local eateries at reduced prices. Completely rotten tomatoes were sold off to animal farmers at bargain prices. This way, vegetable traders found a way of making as much as possible from the inevitable deterioration of the vegetables as explained by a participant:

> *Even completely crushed vegetables are still profitable. I sell all of mine.* (Ejisu T-lab)

Factors that influence access to market infrastructure

The women reported three main factors influencing access to market infrastructure: (1) service availability, (2) power or social position and (3) cost. At the local level, the municipal authority is responsible for building and managing marketspaces. They provide the sheds, electricity, stalls, toilets and others. They are expected the deliver these services with funds from the municipal common fund and taxes levied on market traders. Unfortunately, the provision is non-existent, irregular in spaces and not maintained. According to the women, "*proper sanitation facilities that meet the demand levels of market users are not available at the market*". (Ejisu T-lab)

For available infrastructure, access can be dependent on power or social position at the market. For example, the distribution of resources is shared according to hierarchy, first to the market queen, then to commodity queens and lastly to all other traders. Since there is usually not enough to go to everybody, only a few traders do access. The final determinant of access to infrastructure was cost. Access to the infrastructure came at a cost, and traders had to pay. Some women have low capital levels, so paying for these services was seen as expensive and out of their means as shown in the statement below:

> *"There is electricity at our market, but you need to get a meter, pay electricians and load credits to get it going. It is quite expensive, and most of us cannot afford it."* (Ayigya T-lab)

Discussion

The informal market is the largest employer and the most important distributor of food items in urban centers in Africa. This study investigated the characteristics of vegetable traders, their access to trading infrastructure, trading cost, and profits in Kumasi and Ejisu, Ghana. The current study revealed that most traders were self-employed women with low education who worked for long hours. The majority of them did not have access to basic amenities in the market. Vegetable spoilage was the most important cost associated with their trade apart from stocking. The women sold the best vegetables at high prices and sold the bruised and rotten vegetables to local eateries and animal farms to make some profit. Through these strategies, the women could increase their profit margin but contribute to unsafe handling practices, the high price of food and waste.

This study showed that most of the vegetable traders were self-employed women with low education. Most of the women had inherited their trade. These findings were corroborated by evidence from other African countries as the characteristics of these markets were quite similar (Osei-Boateng and Ampratwum, 2011; Horwood et al., 2019). The informal market's sheer size, diversity, and inclusiveness allowed everyone to participate, particularly the less educated and people with limited opportunities. The International Labor Organization estimates that the informal market absorbs about 50–75% of all self-employed people in low-income countries (Galdino et al., 2018; Horwood et al., 2019; Adesiyun et al., 2021).

Overall, the vegetable market functioned as a transit point for the distribution of vegetables in the city. The trading infrastructure available in the markets buttresses this point. The traders had limited access to electricity, water, sanitation, and storage facilities. As a result of the infrastructural limitations, there were limited opportunities for safe handling and storing vegetables. Our findings can explain the high microbial load of vegetables on the market (Saba and Gonzalez-zorn, 2011; Nyenje et al., 2012; Yeleliere et al., 2017). In 2016, the Kumasi Metropolitan Assembly reported poor sanitation, hygiene, and congestion at the markets in the metropolis (Kumasi Metropolitan Assembly., 2015). Unfortunately, our findings in 2020 confirm the assembly's report and indicate that not much has been invested in improving conditions in the market,

especially markets that have been earmarked for modernization, such as Asafo, Ejisu and Bantama.

According to Osei-Boateng and Ampratum, food traders are low-income earners (2011). In our study, we found that some vegetable traders make about 25.77 US$ a week. Although, this may not may not fully reflect incomes within the sector, the reported income was higher than the minimum weekly wage for the country as of April 2021. The high prices can explain the relatively high income of the vegetable traders. The vegetable value chain rewards the traders despite the poor attention to food security and safety. For example, the high cost of vegetables is the dominant barrier to vegetable consumption, especially among low-income families (Tallant et al., 2018; Kehoe et al., 2019; Kasprzak et al., 2020). Selling wholesome goods is a food safety criteria defined by the Ghana Food and Drugs Authority (FDA Ghana., 2022). However, the traders did not comply with this food safety criteria as they sold rotten vegetables to consumers in order not to lose money. Other studies have reported ignoring the social good to ensure profit among other food traders (Rheinländer et al., 2008; Owusu-Sekyere and Amoah, 2020). Food traders can break the laws because some regulations are unclear and not enforced (Forkuor et al., 2017).

Transforming the informal food distribution market would require changes and commitment from all the actors involved in the sector. We recommend that national and municipal government policies and budgets allocated for market development projects should be disbursed. This would ensure that there are funds for maintaining and developing new infrastructure to address the lack and limit the potential congestion and sanitation challenges in the marketplaces. Although there is usually tension between the municipal authorities and market leaders (Asante and Helbrecht, 2019), the challenge of improper food handling would require collaboration. Community market leaders have been reported to settle disputes, facilitate educational programs and ensure traders observe market rules and regulations. The local authorities and market leaders can ensure that traders regularly receive education on market rules and regulations through collaborative activities.

The findings of this study have highlighted that there are still challenges with access to infrastructure at traditional markets such as storage, electricity and sanitation, even though vendors work at the markets for long hours. Also, the study has expanded our understanding of the nuance strategies adopted by vegetable traders in light of the limited resources available to them and how this influence vegetable handling, safety and waste. Although this study provides an understanding of the activities of vegetable traders at markets, the study did not measure the quantity of food loss at these markets. This is crucial since vegetable spoilage is the dominant cost associated with the trade and also the reason for the high price of vegetables. Future studies can quantify the loss and waste, and the price of the vegetables. In addition, the content of the learning journey was influenced by the perspectives of the research team and local officers. This perspective could be biased based on the expectations and experiences of the team. From our findings, we noticed that most of the views at the transformation labs were consensual. This could have been influenced by the strong group nature of the women who were recruited by the market queens. Future studies that apply the transformation lab approach can consider recruiting participants through invitations of the research of team, instead of through the market queens as was done in this study.

Conclusion

This study examined vegetable traders, the trading infrastructure available to them in the market, and how these factors affect food safety and waste. The majority of the traders did not have access to basic amenities in the market. Vegetable loss was the most important cost associated with their trade. The women sold the best vegetables at high prices and sold the bruised and rotten vegetables to local eateries and animal farms to make some profit. According to the finding of this study, the high prices demanded by the market vendors could increase food insecurity of low-income households. Furthermore, the handling practices of the vendors can contaminate the produce. However, since vegetable trading is the livelihood of the women, adopting oppressive governance approaches, which is the common tool that has been used over the years, may not be helpful. Instead, we recommend collaboration between city and market authorities.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Ethics Review Committee, Kwame Nkrumah University of Science and Technology. The patients/participants provided their written informed consent to participate in this study.

Author contributions

SK, MB, and PC: funding acquisition. SK and MK: conceptualization of manuscript, formal analysis, and

original draft preparation. MB: data collection. All authors contributed to manuscript revision, read, and approved the submitted version.

Funding

This work is based on the research supported wholly by the LIRA 2030 Africa Programme, which is implemented by the International Science Council (ISC) in partnership with the Network of African Science Academies (NASAC), with support from the Swedish International Development Cooperation Agency (Sida). Project number: Lira2030-GR01/19.

Acknowledgments

We sincerely want to thank all the market women and municipal officers who participated this study. We are grateful for their time. We are also grateful to the reviewers and editors for their constructive criticism and suggestions. Their suggestions greatly improved this paper.

Conflict of interest

Author PC was employed by ICLEI Africa.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Author disclaimer

The views expressed herein do not necessarily represent those of NASAC or ISC or Sida.

References

Adesiyun, A. A., Fasina, F. O., Abafe, O. A., Mokgoatlheng-Mamogobo, M., Adigun, O., and Mokgophi, T., et al. (2021). Occurrence and concentrations of residues of tetracyclines, polyether ionophores, and anthelmintics in livers of chickens sold in the informal market in Gauteng Province, South Africa. *J. Food Prot.* 84, 655–663. doi: 10.4315/JFP-20-312

Agyapong, F., and Ojo, T. K. (2018). Managing traffic congestion in the Accra Central Market, Ghana. *J. Urban Manag.* 7(2), 85–96. doi: 10.1016/j.jum.2018.04.002

Amo-Adjei, J., and Kumi-Kyereme, A. (2014). Fruit and vegetable consumption by ecological zone and socioeconomic status in Ghana. *J. Biosoc. Sci.* 1–19. doi: 10.1017/S002193201400025X

Anyidoho, N. A., and Steel, W. F. (2016). Informal-formal linkages in market and street trading in Accra. *Afr. Rev. Econom. Finan.* 8, 171–200.

Asante, L. A. (2020). Urban governance in Ghana: the participation of traders in the redevelopment of Kotokuraba Market in Cape Coast. *Afr. Geogr. Rev.* 39, 361–378. doi: 10.1080/19376812.2020.1726193

Asante, L. A., and Helbrecht, I. (2019). Changing urban governance in Ghana: the role of resistance practices and activism in Kumasi. *Urban Geography.* 40, 1568–1595. doi: 10.1080/02723638.2019.1631109

Asante, L. A., and Helbrecht, I. (2020). Urban regeneration and politically-induced displacement in a secondary African city: a case of the Kotokuraba Market Project, Cape Coast, Ghana. *Geoforum.* 115, 21–33. doi: 10.1016/j.geoforum.2020.06.017

Asiedu, A. B., and Agyei-Mensah, S. (2008). Traders on the run : activities of street vendors in the Accra Metropolitan Area, Ghana. *Norwegian J. Geogr.* 1951. doi: 10.1080/00291950802335806

Balineau, G., Bauer, A., Kessler, M., and Madariaga, N. (2021). *Food Systems in Africa: Rethinking the Role of Markets. Africa Development Forum Series.* Paris: A Copublication of the Agence française de développement; Washington, DC: The World Bank.

Battersby, J., Marshak, M., and Mngqibisa, N. (2016). *Mapping the Informal Food Economy in Cape Town, South Africa.* Waterloo, ON: Hungry Cities Partnership. Hungry Cities Partnership. p. 1–22.

Bhattacharya, H., and Reang, T. (2014). Safety of street foods in Agartala. *North East India Public Health.* 128, 746–748. doi: 10.1016/j.puhe.2014.05.013

Boatemaa, S., Barney, M., Drimie, S., Harper, J., Korsten, L., and Pereira, L. (2019). Awakening from the listeriosis crisis: food safety challenges, practices and governance in the food retail sector in South Africa. *Food Control.* 104, 333–342. doi: 10.1016/j.foodcont.2019.05.009

Clark, G. (1994). "Onions are my husband: Survival and accumulation by West African market women," in *Analisis Standar Pelayanan Minimal Pada Instalasi Rawat Jalan di RSUD Kota Semarang.* The University of Chicago Press. doi: 10.7208/chicago/9780226107769.001.0001

Clark, G. (2010). Gender fictions and gender tensions involving "traditional" asante market women. *African Studies Q.* 11, 43–66.

Cramer, C., Pereira, L., Drimie, S., Wills, J., and Kushitor, S. B. (2019). *T-Lab on Coastal Wild Foods in the Western Cape.* Stellenbosch: Southern Africa Food Lab.

FDA Ghana. (2022). *A Guide to Safter Foods.* Available online at: https://www.fdaghana.gov.gh/img/safety/A~GUIDE~TO~SAFER~FOODS~-merged-compressed.pdf

Forkuor, J. B., Akuoko, K. O., and Yeboah, E. H. (2017). *Effective and Inclusive Regulation of Street Foods in Kumasi: Promoting Food Safety, Protecting Consumers and Enhancing the Well-being of Food Vendors.* https://dfcentre.com/wp-content/uploads/2017/03/2017-03-27_11-P21-GHA-Kwasi-Ohene-Yankyera.pdf

Frank, L., Jannasch, F., Kröger, J., Bedu-Addo, G., Mockenhaupt, F., and Schulze, M., et al. (2015). A dietary pattern derived by reduced rank regression is associated with Type 2 Diabetes in an urban Ghanaian population. *Nutrients.* 7, 5497–5514. doi: 10.3390/nu7075233

Fuseini, I., Battersby, J., and Jain, N. (2018). "The characteristics of the urban food system in Kitwe, Zambia: a focus on the retail sector," in *Urban Food Systems Governance and Poverty in Africa,* Jane, B., and Watson, V. (Eds.). Routledge (p. 195–220). doi: 10.4324/9781315191195-15

Fuseini, I., and Sichone, O. (2018). "Food poverty in Kitwe, Zambia," in *Urban food systems governance and poverty in Africa* Battersby, J., and Watson, J. (Eds.). Routledge (p. 238–248). doi: 10.4324/9781315191195-18

Galdino, K. M., Kiggundu, M. N., Jones, C. D., and Ro, S. (2018). The informal economy in pan-Africa: review of the literature, themes, questions, and directions for management research. *Africa J. Manag.* 4, 225–258. doi: 10.1080/23322373.2018.1517542

Goodfellow, T. (2018). Seeing political settlements through the city: a framework for comparative analysis of urban transformation. *Dev. Change* 49, 199–222. doi: 10.1111/dech.12361

Greaves, L., Bradley, C., and Holley, D. (2012). Learning journeys: exploring approaches to learner digital literacy acquisition. *J. Soc. Sci. Educ.* 4, 1–17. doi: 10.11120/elss.2012.04020003

Horwood, C., Haskins, L., Alfers, L., Masango-Muzindutsi, Z., Dobson, R., and Rollins, N. (2019). A descriptive study to explore working conditions and childcare practices among informal women workers in KwaZulu-Natal, South Africa: identifying opportunities to support childcare for mothers in informal work. *BMC Pediatrics.* 19, 1–11. doi: 10.1186/s12887-019-1737-7

Ikioda, F. O. (2013). Urban markets in Lagos, Nigeria. *Geography Compass.* 7, 517–526. doi: 10.1111/gec3.12057

Kasprzak, C. M., Sauer, H. A., Schoonover, J. J., Lapp, M. M., Leone, L. A., and Kasprzak, C. M., et al. (2020). Barriers and facilitators to fruit and Vegetable consumption among Lower-income families: Matching preferences with stakeholder resources. *J. Hunger. Environ. Nutr.* 1–19. doi: 10.1080/19320248.2020.1802383

Kazembe, L. N., Nickanor, N., and Crush, J. (2019). Informalized containment : food markets and the governance of the informal food sector in Windhoek, Namibia. *Environ. Urban*. 31, 461–480. doi: 10.1177/0956247819867091

Kehoe, S. H., Dhurde, V., Bhaise, S., Kale, R., Kumaran, K., and Gelli, A., et al. (2019). Barriers and facilitators to fruit and vegetable consumption among rural indian women of reproductive age. *Food Nutr. Bull.* 40, 87–98. doi: 10.1177/0379572118816459

Kumasi Metropolitan Assembly. (2015). *Implementation of Metropolitan Medium-Term Development Plan 2014-2017: Annual Progress Report for 2014*. Available online at: https://new-ndpc-static1.s3.amazonaws.com/CACHES/PUBLICATIONS/2016/01/11/AR-$+$Kumasi$+$Metropolitan_2014_APR.pdf

Kushitor, S. B., Curries, P., Drimie, S., Badu, M., Faragher, T., and Bhikoo, J., et al. (2020). *System approaches to food and nutrition security and urban resilience: Lessons from Cape Town.* South Africa and Kumasi, Ghana.

Lartey, N. L. (2021). *Lack of funds hampering renovation of Accra markets – Mayor*. Available online at: https://citinewsroom.com/2021/01/lack-of-funds-hampering-renovation-of-accra-markets-mayor/

Middleton, L. (2016). *Feeding Africa's cities in the 21st century* (No. 4). Available online at: https://www.urbanafrica.net/wp-content/uploads/2016/06/Food_ENG.pdf

MyNews,GH. (2022). *Ultra-modern Kejetia Market Phase 1 develops structural defects after 6yrs*. Business. Available online at: https://www.mynewsgh.com/ultra-modern-kejetia-market-phase-1-develops-structural-defects-after-6yrs/

Nyenje, M. E., Odjadjare, C. E., Tanih, N. F., Green, E., and Ndip, R. N. (2012). Foodborne pathogens recovered from ready-to-eat foods from roadside cafeterias and retail outlets in Alice, Eastern Cape Province, South Africa: Public health implications. *Int. J. Environ. Res. Public Health.* 9, 2608–2619. doi: 10.3390/ijerph9082608

Olsen, W. (2004) "Triangulation in social research: Qualitative and quantitative methods can really be mixed," in *Developments in Sociology Vol. 20*, ed M. Holborn (London: Macmillan).

Omari, R., and Frempong, G. (2016). Food safety concerns of fast food consumers in urban Ghana. *Appetite.* 98, 49–54. doi: 10.1016/j.appet.2015.12.007

Osei-Boateng, C., and Ampratwum, E. (2011). *The Informal Sector in Ghana*. Available online at: https://library.fes.de/pdf-files/bueros/ghana/10496.pdf

Owusu, G., and Lund, R. (2004). Markets and women's trade: Exploring their role in district development in Ghana. *Norsk Geografisk Tidsskrift*. 58, 113–124. doi: 10.1080/00291950410002313

Owusu-Sekyere, E., and Amoah, S. T. (2020). "Urban design, space economy and survival in the city: Exploring women's world of work in Kumasi, Ghana," in *Sustainability in Urban Planning and Design* Almusaed, A., Almssad, A., and Troung-Hong, L. (Eds.). Intechopen. doi: 10.5772/intechopen.89673

Resnisck, D. (2017). *Why Brutalizing Food Vendors Hits Africa's Growing Cities Where It Hurts. Research Post*. Available online at: https://www.ifpri.org/blog/why-brutalizing-food-vendors-hits-africas-growing-cities-where-it-hurts

Rheinländer, T., Olsen, M., Bakang, J. A., Takyi, H., Konradsen, F., and Samuelsen, H. (2008). Keeping up appearances: Perceptions of street food safety in urban Kumasi, Ghana. *J. Urban Health*. 85, 952–964. doi: 10.1007/s11524-008-9318-3

Saba, C. K. S., and Gonzalez-zorn, B. (2011). Emerging Problems in Infectious Diseases Microbial food safety in Ghana : a meta-analysis. *J. Infect. Dev. Ctries.* 6, 828–835. doi: 10.3855/jidc.1886

Southern Africa FoodLab. (2019). *Food System Dialogue*. Available online at: https://www.southernafricafoodlab.org/foodsystemchange/

Southern Africa FoodLab. (2021). *Strengthenining Local Food Netwroks for Food Systems Transfromation: Learning Journey and Transformation Lab Report*. Available online at: https://www.southernafricafoodlab.org/wp-content/uploads/2021/01/Report-on-the-learning-journey-and-transformation-lab-event-Strengthening-local-food-networks-final.pdf

Stacey, P., Grant, R., and Oteng-Ababio, M. (2021). Food for thought: Urban market planning and entangled governance in Accra, Ghana. *Habitat Int*. 115, 102400. doi: 10.1016/j.habitatint.2021.102400

Tallant, A., Rettig, M., and Tennyson, S. (2018). Barriers and facilitators for fruit and vegetable consumption among adults in rural counties. *Family Consum. Sci. Res. J.* 47, 87–100. doi: 10.1111/fcsr.12275

Tete Larbi, R., Yaw Atiglo, D. I., Peterson, M. B., Biney, I. D., Dodoo, N. D., Dodoo, N., et al. (2021). Household Food Sources and Diarrhoea Incidence in poor urban communities, Accra Ghana. *PloS ONE*. 16, e0245466. doi: 10.1371/journal.pone.0245466

Tomlins, K., Johnson, P. N., Aseidu, O. P., Myhara, B., and Greenhalgh, P. (2002). *Street Food in Ghana: A Source of Income, But Not Without Hazards*. Available online at: www.iita.org/info/phnews5/mr8.htm (accessed March 01, 2011).

Tuholske, C., Andam, K., Blekking, J., Evans, T., and Caylor, K. (2020). Comparing measures of urban food security in Accra, Ghana. *Food Security*. 12, 417–431. doi: 10.1007/s12571-020-01011-4

Walls, H., Baker, P., Chirwa, E., and Hawkins, B. (2019). Food security, food safety and healthy nutrition: are they compatible? *Global Food Security*. 21, 69–71. doi: 10.1016/j.gfs.2019.05.005

WBT Systems. (2021). *How to Use Learner Journey Mapping to Improve the Educational Experience*. Topclass. Available online at: https://www.wbtsystems.com/learning-hub/blogs/learner-journey-mapping

Wilder, J., and Lillvist, A. (2018). Learning journey: A conceptual framework for analyzing children's learning in educational transitions. *European Early Childhood Education Research Journal. 26*(5), 688–700. doi: 10.1080/1350293X.2018.1522736

Wilson, N. L. W., and Worosz, M. R. (2014). Zero tolerance rules in food safety and quality. *Food Policy*. *45*, 112–115. doi: 10.1016/j.foodpol.2013.11.004

Yeleliere, E., Cobbinah, S. J., Abubakari, Z. I., and Yildiz, F. (2017). Review of microbial food contamination and food hygiene in selected capital cities of Ghana. *Cogent Food and Agriculture.* 3, 1395102. doi: 10.1080/23311932.2017.1395102

Zgambo, O., Pereira, L., Drimie, S., and Boatemaa, S. (2018). *T-Labs for Alternative Food Systems in the Western Cape*. Available online at: https://www0.sun.ac.za/cst/publication/t-labs-for-alternative-food-systems-in-the-western-cape