

Transformative Bottom-Up Change in Highly Dynamic Food Environments: Learning From Living Labs in Africa

Ardjan Vermue¹, Henk Renting¹, Celine Termote², Consolata Musita²,
Claudia Segreto³, and Sigrid Wertheim-Heck⁴

¹ Urban Food Issues, Aeres University of Applied Sciences Almere, The Netherlands

² Food Environment and Consumer Behaviour, Bioversity International, Kenya

³ Independent Researcher, Italy

⁴ Environmental Policy, Wageningen University, The Netherlands

Correspondence: Ardjan Vermue (a.vermue@aeres.nl)

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Abstract

The relationship between food environments, diets, and consumption practices is essential in improving nutrition and health outcomes. Despite growing research in higher income countries on such interactions, less is known about food-environment dynamics in lower income countries, where food insecurity, malnutrition, and informal markets play a key role. HealthyFoodAfrica is a five-year research and innovation project aimed at promoting more sustainable, equitable, resilient, and health-enhancing food systems in 10 African cities by reconnecting food production and consumption. In each locality a bottom-up food system lab (FSL) was established as a driver for co-creating a range of interventions across the food system. This article first presents a food environment lived-experience framework based on practice and theory, allowing for a contextualized understanding of food environments in these diverse settings. It regards the food environment as a dynamic constellation, in which FSLs co-create and drive bottom-up initiatives directing food environment dynamics towards the common goals of improved health and better sustainability outcomes. We map the focus and impact pathways of interventions from four selected FSLs within their local food systems, recognising that the complexity of these informal urban environments makes isolated causal effects difficult to discern. Examining these diverse interventions through a common analytical lens enabled us to identify unique trajectories, as well as shared mechanisms, in how urban food environments evolve. To conclude, we discuss the implications of our findings and provide recommendations on how informality, bottom-up dynamics, and self-organisation can be better supported in urban planning in African cities.

Keywords

bottom-up governance; food environments; food security; healthy and sustainable diets; informality; lived experience research; social practice theory

1. Introduction

Rapid urbanisation is profoundly transforming food systems across Africa, giving rise to dynamic urban food environments that shape dietary and environmental outcomes, as well as the equity and resilience of food systems. Recent studies underline the complex interplay between food environments, dietary choices and malnutrition in low-income urban settings (Battersby & Watson, 2018; Turner et al., 2018). Food environments, encompassing the physical, economic, and socio-cultural settings in which people acquire and consume food, are now recognised as critical in shaping what people eat (Blake et al., 2021). Consequently, improving urban diets and nutrition requires engaging with these environments as potential levers for change (HLPE, 2017). However, our understanding of how African urban residents actually experience and interact with the real-world dynamics of food environments remains limited (Turner et al., 2020).

Many African cities are marked by sprawling informal settlements, fluid markets, and self-organising community networks that defy the formal/informal dichotomies of classic food environment assessments (Crush & Riley, 2018; Skinner & Haysom, 2016). Given this complexity, African urban food environments are better seen as “messy” and constantly evolving social realities with unpredictable dynamics (Law, 2004). Current governance responses to promote healthy diets remain largely top-down, formalised, and linear and have often proven ineffective in addressing complex food environment changes (Battersby & Watson, 2018). There is a need for alternative bottom-up approaches and locally grounded interventions that engage communities in guiding dietary transitions toward healthier and more sustainable outcomes (Nikolaidou et al., 2023). Reviews of real-world and living-lab experiments confirm that empirical insights into how bottom-up, co-creative processes unfold, and how they can be steered, remain scarce (Bulkeley et al., 2016; Steen & van Bueren, 2017). Our article explores how food environments, diets, and everyday consumption practices interact in African urban contexts, with a focus on low-income areas characterised by food insecurity, malnutrition, and informal markets. Using experiences from real-world living-labs, we provide insights into how transformative changes in highly dynamic food environments can be realized from the bottom up, ultimately orienting food systems toward healthier diets.

Under-nutrition and other forms of malnutrition exemplify the urgency of this challenge. One in every five people in sub-Saharan Africa is undernourished, a proportion that has been rising since the Covid-19 pandemic and is projected to increase further due to climate change, rapid urban growth, and persistent poverty (van Dijk et al., 2021). Urban malnutrition is characterized by a “triple burden”: the coexistence of under-nutrition, micronutrient deficiencies, and rising overweight and obesity, all linked to poor diets (Ahinkorah et al., 2021). In slum areas, for example, 26–50% of children under five are stunted, indicating severe chronic under-nutrition (Mutisya et al., 2020). At the same time, global forces such as volatile food prices, climate-induced shocks, and aggressive marketing of ultra-processed foods are destabilizing local diets (Holdsworth & Landais, 2019). In addition, diets across Africa are shifting away from traditional, plant-rich foods toward more processed, Western-style patterns, driven by globalisation, urbanisation, modernisation, and an “urbanisation of poverty” (Temba et al., 2025). These dietary changes are associated

with rising rates of obesity and diet-related non-communicable diseases, and also pose sustainability concerns. Westernized diets generally have higher greenhouse gas emissions and resource demands than Africa's indigenous diets, which tend to be more plant-based and locally sourced (Oniang'o et al., 2025). These trends underscore that improving nutrition in African cities is not merely a matter of increasing food supply, but of fundamentally reshaping food environments and consumption patterns to support sustainable healthy diets (FAO & WHO, 2019).

In what follows, we present our conceptual framework informed by social practice theories, which enables us to centre lived experiences in our understanding of urban food environments. Our investigation is grounded in the HealthyFoodAfrica (HFA) project, a five-year initiative (2020–2025) operating in 10 African cities. HFA established a series of bottom-up food system labs (FSLs) as “living laboratories” for co-creating context-specific food system innovations. Instead of imposing external solutions, each FSL convened local stakeholders, including producers, vendors, consumers, and policymakers, to design and implement interventions tailored to local needs. This article focuses on four FSL cases: Kisumu (Kenya), Fort Portal and Rwamwanja (Uganda), and Cotonou (Benin). Each case targets different, interrelated food environment elements (e.g., urban agriculture, nutrition education, markets, and food safety). They span a range of urban contexts, ranging from dense informal settlements and inner-city markets, to a peri-urban refugee town, all characterized by informality and rapid growth. We map the focus and impact pathways of each intervention within its local food system, while recognizing that the complexity of these informal urban environments makes isolated causal effects difficult to discern. Examining these diverse interventions through a common analytical lens allows us to identify unique trajectories as well as shared mechanisms in how urban food environments evolve. Finally, we discuss the implications of our findings and conclude with recommendations for urban planning in African cities.

2. Conceptual Framework

2.1. FSLs as Consumption Junctions

The overall goal of the HFA project is to make food systems more sustainable, equitable, and resilient by reconnecting food production and food consumption in effective ways. The FSLs serve as experimental “consumption junctions” that focus on where consumption practices and provisioning systems intersect (Cowan, 1987). Extending Cowan's concept from technology adoption to food provisioning, we treat elements of the food environment, such as supermarkets, open-air markets, and community gardens, as consumption junctions. In these spaces, consumers turn broad ideas about health, ethics, and the environment into acquisition practices: the foods they buy or otherwise obtain for consumption (Oosterveer et al., 2007). Drawing on the Chicago School's portrayal of the city as a natural laboratory for the study of collective human behaviour (Park et al., 1925), we frame each FSL as a real-world experimental site in which citizens, vendors, and officials co-create diverse and alternative provisioning–consumption couplings. These are, effectively, experiments in consumption practices in the real world, where citizens are the experts in the context in which they live (Brons et al., 2022). Contemporary living-lab methods build on the Chicago School's tradition—embedding researchers and citizens in co-creative experimentation, allowing them to co-create and study how new practices arise, stabilise, or fade within an urban setting (Chronéer et al., 2019).

2.2. Social Practice Theory

Consumption choices are embedded in everyday routines and social contexts (Spaargaren & van Vliet, 2000). The consumption junction defeats the idea of a one-way influence on consumer behaviour, seeing the food environment as the emergent outcome of a myriad of interactions between citizen-consumers and the systems that provision food. To capture this dynamic, we adopt a social practice theory lens in order to understand urban food environments as lived systems. Practice theory shifts the focus from individual decisions or static structures to the routine practices through which people procure, prepare, and consume food (Halkier & Jensen, 2011). In African cities, this means seeing food environments as the lived reality of how people find, eat, and sometimes produce food each day, rather than as static “foodscapes” defined only by shopping locations or food availability metrics (Spires et al., 2023). Schatzki’s (2002) concept of the “site of the social,” central to social practice theory, reinforces this view: an urban food environment is a nexus of interrelated practices and material arrangements. A marketplace or community garden is not just a physical location but an ensemble of activities, norms, and artefacts that make up the social life of that place. Viewing urban food environments as sites produced through practice helps explain how shifts in practice (for example, adopting urban gardening or new cooking habits) can ripple through and reconfigure the food environment over time. This approach builds on recent models that integrate practice theory into food environment research and highlight the messiness and volatility of consumption patterns in cities (Brons et al., 2020; Wertheim-Heck & Raneri, 2020), extending them to Africa’s highly informal, fluid contexts.

2.3. Urban Informality and Self-Organisation

A practice lens also highlights the hybrid nature of African urban food systems, notably the blurred lines between formal and informal food markets and the prevalence of bottom-up organisation. The informal food sector is pervasive and central: most urban residents, especially lower-income households, get most of their daily food from informal markets and street vendors. Here, informality is not just a lack of regulation; it is an “organising logic” of urban life (Roy, 2005), a set of flexible arrangements through which communities secure food. These informal markets are often essential for food security, providing affordable, convenient access where formal retail is scarce (Holdsworth & Landais, 2019). For instance, one review found street foods contribute 13–50% of adults’ daily energy intake in African cities (Steyn et al., 2014). Far from being a stopgap for the poor, informality can be a resource for innovation and resilience: informal vendors respond quickly to changing demand and community networks fill gaps in provision during crises (Banks et al., 2020; Vorley, 2023). Our framework therefore treats informal practices and actors as fundamental components of the food environment. Notably, many of these informal food system innovations emerge through community self-organisation, sometimes filling gaps left by the state and at other times operating in parallel beyond the state (Boonstra & Boelens, 2011; Polese, 2021).

Figure 1 outlines our practice-oriented framework to analyse how FSL interventions modify local food practices. For each case, we mapped how daily activities intersect with available food sources, and how the intervention shifts those interactions. Importantly, we treat diets as both the guiding aim of these interventions and a dependent variable that emerges from changes in practice, rather than a directly measured outcome. Instead of quantifying short-term dietary changes, we focus on how interventions reshape the practice context in ways expected to enable healthier dietary patterns over time.

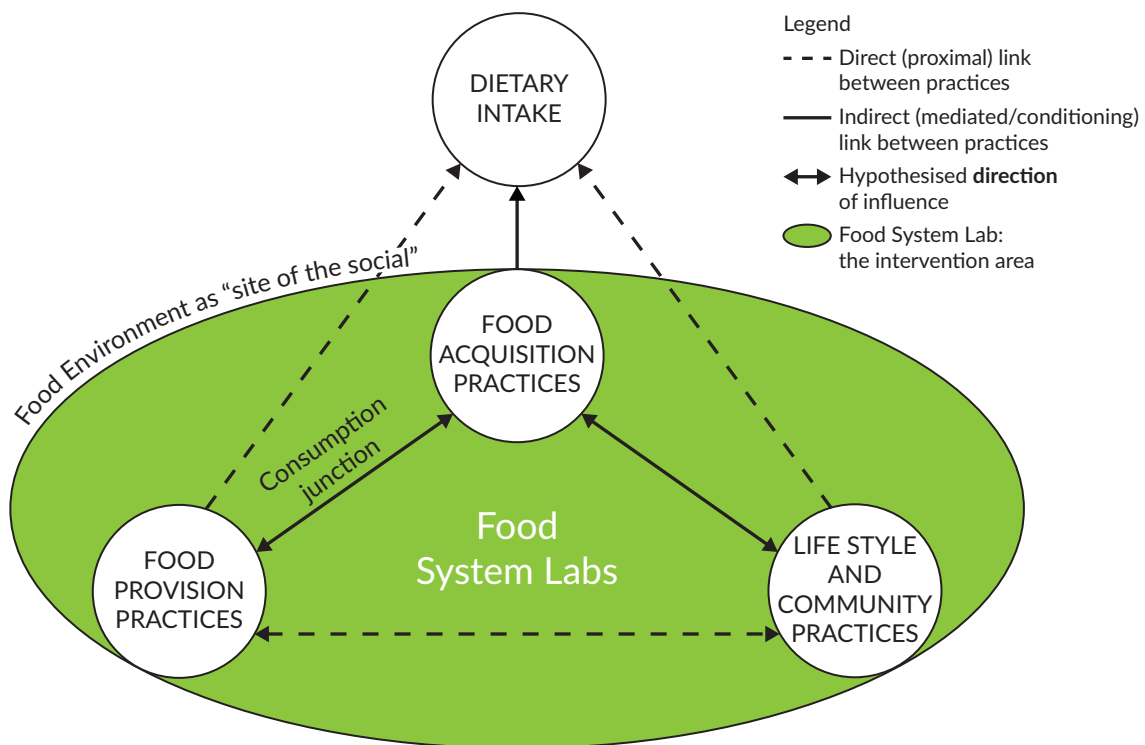


Figure 1. Conceptual framework. Source: Adapted from Wertheim-Heck and Raneri (2020).

3. Methodology

This study employed a multi-case participatory action research (PAR) design, using mixed methods, to capture the unique complexities of dynamic food environment interactions, while also identifying broader conceptual themes across multiple cases (Fletcher et al., 2015). Following comparative urbanism, we mix qualitative and quantitative survey items with ethnography (Robinson, 2022). The use of social practice theory is particularly well-suited for living lab research (Hasselkuß et al., 2017), forming the theoretical basis through which the lived-experience empirical lens of FSL experimentation is observed and interpreted. Researchers and local stakeholders co-developed and tested solutions in real-world settings, forming a joint process of knowledge-production (Bergold & Thomas, 2012). Using an ethnographic orientation in PAR enabled close engagement with everyday realities, enhancing the depth and contextual sensitivity of the research. This design allowed us to both enact changes through FSLs and analyse how these changes unfold in practice.

3.1. Case Studies

Empirical research was conducted within the HFA research and innovation project, which established FSLs in 10 African cities and supported them through thematic and cross-cutting work packages. Each FSL was initiated by or built upon a previously existing multi-stakeholder platform by a local organisation in its urban locality and received methodological guidance and monitoring from the thematic work packages. For this article, we selected four FSLs for an in-depth, comparative analysis: Kisumu (Kenya), Fort Portal and Rwamwanja (Uganda), and Cotonou (Benin; see Figure 2 for locations).



Figure 2. Overview of the geographical locations of the four FSLs.

These FSLs were selected because of the multifaceted nature of the food environment transformation that they entail. Together they represent a meaningful diversity of urban contexts and challenges. Cases were purposively sampled using two criteria: (i) completeness and conceptual comparability of evidence and (ii) that they represented maximum variation across urban contexts and food-system challenges. Four out of 10 FSLs completed baseline and endline assessments and maintained consistent qualitative/ethnographic records, out of which the three most diverse cases were selected (Cotonou, Kisumu, Fort Portal); Rwamwanja was included to represent a peri-urban refugee context and because it generated rich qualitative data. Each case targets different, interrelated food-environment elements (e.g., urban agriculture, nutrition education, markets, and food safety). Table 1 provides an overview of the selected cases.

Table 1. Summarised characterisation of the four FSLs (compiled from external sources). References are included in the detailed FSL descriptions (results section).

FSL	Kisumu (Kenya)	Rwamwanja (Uganda)	Fort Portal (Uganda)	Cotonou (Benin)
City	Lakeside	Peri-urban refugee	Fast-growing	Coastal metropolitan
Characteristics	conurbation; ~600,000 inhabitants; rapid rural influx fuels dense, sprawling informal settlements	settlement; ~100,000 inhabitants; high density; still expanding with Congoese refugee waves	trade/tourism centre; ~470,000 inhabitants; compact urban core draws continual rural in-migration	city; ~670,000 inhabitants; medium density; expanding through steady rural influx

Table 1. (Cont.) Summarised characterisation of the four FSLs (compiled from external sources). References are included in the detailed FSL descriptions (results section).

FSL	Kisumu (Kenya)	Rwamwanja (Uganda)	Fort Portal (Uganda)	Cotonou (Benin)
Food System Challenges	High poverty in informal settlements; widespread food insecurity and malnutrition (only ~21% households are food secure); poor dietary diversity; triple burden of malnutrition	Very high malnutrition; stunting ~41% vs 26% national; low agricultural productivity; limited market access; weak farmer organisations; low dietary diversity	Persistent malnutrition (stunting ~40% among children < 5) despite abundant local food production; poor dietary diversity, low nutritional awareness	High urban poverty; food insecurity (only ~18% households are food secure); high child malnutrition (~36% stunting); emerging overweight in school-age children
Food Environment Type	Urban with large informal settlements; very high informality in food supply	Peri-urban refugee settlement; highly informal; urban-like challenges despite a rural setting	Urban/peri-urban setting; food landscape dominated by informal markets (street vendors and public markets)	Peri-urban setting; hybrid formal (school canteens) and informal (street vendors) food environment
Level of Food Dependency	High—largely relying on other regions and neighbouring countries	High—residents heavily rely on external food aid from World Food Programme (WFP)	Low—food-surplus region with abundant agricultural output	High—significant reliance on external support (school feeding programs aided by WFP); local fresh produce underutilized

3.2. Theory of Change

The theory of change (ToC) approach guided each FSL to articulate long-term goals for food-system transformation and then work backwards to identify the intermediate outcomes, assumptions, and actions to reach this (Awuh et al., 2022). ToC clarifies how and why desired changes are expected within specific contexts by mapping links between activities, outputs, outcomes, and longer-term impacts. Local stakeholders were involved from the start to build participatory impact pathways, ensuring a collective vision and shared ownership of interventions (Blundo Canto et al., 2020). Each FSL developed its own ToC, aligned with the project-wide framework, and updated it iteratively as interventions unfolded through workshops and stakeholder meetings.

3.3. Operationalisation and Data Collection

Based on the conceptual framework (Figure 1), common indicators connected to the framework's components (food provision practices, food acquisition practices, lifestyle and community practices, and dietary intake) were selected. The *modus operandi* of the FSLs followed five phases: (1) each FSL team adapted instruments and sampling plans for the baseline assessment, fitting local interests and needs; (2) quantitative baselines (2021–2022) were implemented with defined populations (see Annex 1 in the Supplementary File for full details) alongside qualitative assessments such as focus group discussions (FGDs) and key stakeholder interviews; (3) findings informed co-design and updates of the ToCs with stakeholders;

(4) interventions were implemented and monitored, and adjusted during the process where needed; and (5) endline assessments (2024) were conducted to assess overall progress. A site-specific exception was Rwamwanja, which only conducted qualitative endline FGDs and documentation as a quantitative baseline assessment was missing. Full quantitative and qualitative particulars (populations, timing, instruments, indicators, and roles) are provided in Annexes 1 and 2.

3.4. Analysis and Reflection

Our study draws on the rich documentation and reflections generated by the FSLs. The authors worked closely with the FSL partners to synthesise and interpret the outputs of these interventions. In addition to the quantitative endline results, we compiled internal project reports, deliverables and blogs, ToC frameworks, multiple online interviews with FSL leaders, impact assessment strategies, annual consortium meeting notes, and other forms of communication during the project (see Annex 2 for full details). This analysis was both iterative and reflexive. We engaged in regular discussions with FSL teams to support the ToC process, validate interpretations, incorporate their experiential knowledge, and remain sensitive to local nuances. Guided by social practice theory, we analysed changes in FSLs at two interrelated levels. First, we examined how changes occurred in the materials, competences, and meanings that constitute food practices (Shove et al., 2012). Second, we considered how practices interconnect in daily life as bundles, tracing how shifts in one practice travel across connected activities such as gardening, purchasing, cooking, and eating. Our conceptual framework (Figure 1) informed how we studied ToC implementation: it enabled us to observe both dynamic practice constellations (changes in elements) and dynamic practice-bundle constellations (changes in how practices interlink, recognising that change rarely occurs in isolation). Within each case we produced ToC-aligned summaries of activities, outputs, and outcomes, which are presented in the FSL-level results (Section 4). We then compared the key mechanisms across the cases and mapped common impact pathways, which are presented in a comparative analysis (Section 5). Throughout, we remained mindful of our double role as facilitators and researchers. The result is a methodology that is inherently adaptive and human-centred, acknowledging that transforming urban food systems is as much about the process of co-learning and empowerment as about technical solutions.

4. Results

Here, we present the results for the four FSLs, covering an overview of their key food system characteristics, FSL interventions, outcomes and impacts, and lessons and insights.

4.1. Kisumu FSL, Kenya

Kisumu City, situated on the shores of Lake Victoria, is Kenya's third-largest city with approximately 60% of its 600,000 inhabitants living in informal settlements characterized by high population density and poverty (County Government of Kisumu, 2023). Kisumu FSL targets several urban informal settlements, such as Manyatta A, Manyatta B, Obunga, and Bandani, where food insecurity is pervasive and diets are lacking in variety, especially among children (Wagah et al., 2018).

4.1.1. Key Food System Characteristics

Kisumu's food system is primarily informal, with numerous street vendors, informal markets, and unstructured food supply chains dominating food provisioning (Simiyu et al., 2019). The city depends heavily on external sources for food. Much of the food is brought in from other Kenyan counties or imported from the neighbouring country of Uganda, leaving the city vulnerable to external shocks.

Informal traders break bulk goods into small, affordable portions, often relying on informal credit. This informal setup caters for the poorest consumers who purchase food on a day-to-day basis. It also reflects systemic issues: pervasive poverty, volatile food prices, and lack of formal safety nets. Malnutrition rates are alarmingly high in these communities. At baseline, only 21% of households reported being food secure (Annex 1). At the same time, overweight and micronutrient deficiencies co-exist, indicating a triple burden of malnutrition driven by poor quality diets (Sawe et al., 2021). The region has ample agricultural potential, with surrounding rural areas growing African leafy vegetables (ALVs) and Lake Victoria providing fish, yet local consumers often cannot access or afford these foods and imported fish competes with the local fish on the market (Opiyo & Agong, 2020).

4.1.2. FSL Interventions

To address these challenges, the Kisumu FSL implemented a set of interventions focused on promoting the consumption and provisioning of affordable and nutritious foods, particularly ALVs and fish. While the FSL was led by the Alliance of Bioversity International and the International Centre for Tropical Agriculture (CIAT), interventions were jointly developed with the bottom-up engagement of local communities. First, urban gardening demonstration and learning plots were established in six community units, showcasing gardening techniques such as vertical gardens, sack gardens, and other space-efficient methods for growing ALVs. Women and young people were trained by Kisumu County agricultural extension officers and local "urban garden ambassadors," who also established gardens in their homes, serving as learning sites for community members. Harvested vegetables not only improved access to fresh produce for home consumption but created opportunities to sell surpluses to neighbours. Second, an aquaponics system combining fish and vegetable production was established, managed by a community women's group with technical support from county experts.

Alongside enhancing production, the FSL invested in strengthening value chain linkages and governance mechanisms along fish and ALV value chains. A multi-stakeholder platform was initiated, involving farmer groups, fish traders, ALV aggregators, local market leaders, NGOs, and Kisumu County officials. Training sessions were organised to build trust among value chain actors and to improve coordination. The platform facilitated dialogue on market linkages, fair prices, and post-harvest handling, helping to connect producers with urban markets.

Another component was nutritional education and behaviour change communication. The FSL trained community health promoters (CHPs) in nutritional topics such as child feeding, dietary diversification, food safety, and hygiene. The promoters delivered education to informal settlements through home visits, group sessions, and cooking demonstrations to encourage practical learning on preparing healthy and nutritious meals using local ingredients. Importantly, all FSL's interventions were implemented in a participatory

way, allowing community members to engage in the design of interventions and adapt innovations to their context. This emergent, inclusive approach catalysed self-help initiatives (e.g., neighbours forming gardening groups).

4.1.3. Outcomes and Impacts

The Kisumu FSL interventions yielded promising results, with measurable gains for the adoption of urban gardens and improved dietary consumption among women and children. Overall, ownership of urban gardens increased from 4.5% at baseline in March 2022 to 22.4% at endline in August 2024. At endline, 34.8% of intervention households managed gardens compared to only 9.7% for comparison group households.

Using 24-hour recall data (Annex 1), we observed improvements in dietary diversity for children (6–23 months) and women of reproductive age (15–49 years). Among children, the share meeting minimum dietary diversity (MDD-C; ≥ 5 of 8 food groups) rose from 42% to 50%, while the comparison group showed no improvement. At the endline, children's dietary diversity scores (DDS) for the intervention group (3.55) were significantly higher than the comparison group (3.32) ($p = 0.034$). The share of women achieving MDD (MDD-W; ≥ 5 of 10 food groups) increased from 41% to 51% after FSL interventions. Mean DDS for women rose from 4.36 to 4.53, with no significant endline difference between intervention (4.53) and comparison (4.49) groups.

Qualitative reports support these findings. Households with gardens reported consuming ALVs more frequently and even sharing surplus with neighbours. Some households benefitted economically by selling small amounts of produce or fish, thereby increasing their income. While comprehensive income data are not yet available, there are indications that linking ALV farmers to urban markets led to better prices for farmers and a more stable supply for consumers, a win-win for all.

4.1.4. Lessons and Insights

Several lessons emerge from the Kisumu FSL. One key insight is that interventions that integrate supply and demand amplify impact, since improving food production alone would not change nutrition without coupled nutritional education and vice versa ("consumption junction"). Introducing new food sources (such as gardens and aquaponics), alongside behavioural change communication, created synergies and provided people with the knowledge, means, and motivation to diversify their diets.

Another lesson is the importance of community co-creation and ownership. Engaging beneficiaries in design and implementation led to a high acceptance and cultivated a sense of ownership, helping ensure that initiatives will continue beyond the project. It also highlighted the vital but previously undervalued role of existing community structures such as CHPs and urban garden ambassadors, as crucial agents for change in improving diets and practices. These community structures are also key for continuity, including 118 CHPs trained in nutritional education and equipped with education materials, who will continue with nutritional education under Kisumu County's Ministry of Health, and urban garden ambassadors who will continue training community members using their own gardens as learning sites in collaboration with Kisumu County's agricultural extension officers.

In Kisumu's informal settlements, daily routines of buying, selling, and preparing food constitute the “site of the social” where the food system is produced and reproduced (Schatzki, 2002). Examples include women selling vegetables on roadside mats and families making *ugali* (a thick porridge made from maize flour) each evening. Kisumu FSL's interventions successfully engaged with these existing social practices. Rather than attempting to override people's routines, interventions worked within them: for instance, cooking demonstrations built on improving local recipes and traditional meal patterns using local ingredients which participants brought in themselves, instead of introducing entirely new or foreign recipes. The role of urban informality in food systems was also paramount. Far from considering informality to be a governance gap or hindrance, it was approached as a space of innovation and resilience (Banks et al., 2020; Roy, 2005). The FSL multi-stakeholder platform brought together key food system actors to address challenges in all components of the food system. It provided a safe place where actors could share knowledge and exchange ideas on what worked and what was not working and how to address the shared challenges identified in the FSL, supporting the notion of self-organisation (Boonstra & Boelens, 2011). Overall, the Kisumu FSL underscores the importance of aligning nutritional objectives with local informal practices, economic realities, and social dynamics.

4.2. *Rwamwanja FSL, Uganda*

The Rwamwanja FSL is situated in the Rwamwanja refugee settlement in Kamwenge District, south-western Uganda. It hosts approximately 100,000 refugees and asylum seekers, predominantly from the Democratic Republic of Congo (UNHCR, 2025). Despite the area's rural appearance, Rwamwanja faces several urban-like challenges, including informality in food markets, limited resources, and socio-economic vulnerability. It can be considered as a peri-urban setting due to its relatively high population density, total population, and limited size of land plots provided to refugees (0.18–0.32 acres per household).

4.2.1. Key Food System Characteristics

Although located in the Kamwenge District, known as the “food basket” of the Rwenzori sub-region, the food system in Rwamwanja is facing severe nutritional challenges, with stunting rates around 40% (UNHCR, 2017), much higher than Uganda's national average of 26% (UBOS & ICF, 2018). The settlement struggles with low productivity in agriculture, limited market access, and weak farmer organisational structures. Nutritional diversity is low, partly due to widespread cultivation of maize in monoculture systems. The lack of farmer associations further limits improvements in food security and nutrition. Residents depend significantly on external food assistance from the WFP (2024a).

4.2.2. FSL Interventions

The Rwamwanja FSL, led by the NGO Finn Church Aid, addressed these challenges by co-developing and implementing several interventions focusing on the empowerment of smallholder farmers. This focused primarily on women farmers, 70% of whom are refugees and 30% of whom are from the host community. A farmers' cooperative and maize processing plant were established with a decentralised extension system involving local village enterprise agents (VEAs). These VEAs provided extension services and helped organise collective marketing. The maize processing facility allowed value addition through producing maize flour and bran, significantly increasing household incomes. To stimulate farmer households to spend the additional income on healthy food, the VEAs and model farmers were trained to deliver nutritional

education campaigns in their communities to promote better diets and to support the establishment of home vegetable gardens and intercropping of legumes with maize.

4.2.3. Outcomes and Impacts

The Rwamwanja case demonstrates the importance of integrating nutritional objectives into broader livelihood strategies. Farmers who adopted legume intercropping reported yield increases of around 20%. Household incomes increased significantly and revenues from maize rose from 500–650 Ugandan Shillings per kg for raw maize sold directly to middlemen to 1500–1900 Shillings per kg for processed maize flour sold through the cooperative (Annex 2). The increase in incomes and the establishment of home gardens and intercropping practices improved both household nutrition and food security. An unforeseen outcome was that the availability of leftover maize bran from processing encouraged local poultry and piggery production, which in turn increased the consumption of nutritious animal-based foods. In 2025, the WFP conducted a re-evaluation of the need for food assistance inside the refugee settlements. Originally, 80% of the 700 participating Rwamwanja FSL refugees received food assistance based on need categories 1 and 2, where 1 = most vulnerable and 2 = moderately vulnerable. After the re-evaluation, this number reduced to 15%, thanks to the positive impact of the project, and 85% of the refugees are now considered category 3, being self-reliant (WFP, 2025, unpublished data).

4.2.4. Lessons and Insights

The Rwamwanja food environment developed dynamically through everyday social interactions rather than formal interventions, illustrating how informal interactions can become a resource for innovation (Banks et al., 2020; Roy, 2005). Informal interactions, for example at the maize processing facility and informal livestock activities using maize bran, created positive economic and nutritional outcomes.

The case also illustrates the importance of time-space dynamics in shaping changes in social practices (Schatzki, 2010) through practices that followed the agricultural seasons (planting, harvesting, processing, and selling) and influenced when, and how, new interactions occurred. Dependency on middlemen initially determined the low maize prices that farmers were receiving directly after harvests, as they had no other option than to directly sell their produce. The maize mill acted as a central “node” anchoring a nexus of new practices: the milling and collective marketing of maize flour over time, processing high-quality maize and retaining by-products, agricultural training sessions, and nutritional education conducted by VEAs.

The establishment of a farmers’ cooperative and the VEA network illustrates the gradual evolution from informal practices and networks into more structured, collective organisations, without losing the flexibility and responsiveness of informal systems. Self-organisation in Rwamwanja was not straightforward but involved substantial trust-building efforts. Refugees and local farmers initially distrusted each other, and refugee farmers distrusted formal structures and external organisations. This required considerable efforts to build trust through continuous dialogue, demonstrating tangible benefits and facilitating joint activities. This careful process allowed informal practices to gradually develop into a structured farmers’ cooperative and extension system, without losing its flexibility or adaptability.

4.3. Fort Portal FSL, Uganda

Fort Portal and the surrounding Kabarole District in Western Uganda represent a rapidly growing urban area with approximately 470,000 inhabitants (UBOS, 2017). Like Rwamwanja, it is located in Uganda's productive Tooro region, renowned for its abundant agricultural output. Fort Portal paradoxically experiences food system challenges, including significant nutritional deficiencies and food insecurity. In particular, children under five years experience high stunting rates of approximately 40% (UBOS, 2018). Fort Portal is popular as a tourist destination, influencing policy priorities around food safety and the promotion of traditional food practices to attract visitors.

4.3.1. Key Food System Characteristics

Fort Portal's food system is marked by a paradox of food abundance alongside persistent malnutrition, driven by inadequate dietary diversity, suboptimal childcare and breastfeeding practices, gender inequality, and limited nutritional awareness. Informal markets dominate the food landscape, with several public markets, street food vendors, and household producers. This creates vulnerabilities related to food safety and inconsistent nutritional quality.

4.3.2. FSL Interventions

The Fort Portal FSL is led by Kabarole Research and Resource Centre (KRC-Uganda), a long-standing NGO committed to understanding drivers of poverty and its solutions. The FSL and its interventions build on earlier food system initiatives and projects, employing a wide and strategic set of activities to foster nutritional improvements across the entire food environment. It builds upon various existing food system actors, including a previously established "coalition of the willing": food ambassadors (influential leaders who promote healthy diets for all in their respective constituencies), street food vendors, formal chefs, farmer groups, Orugali groups (who engage in traditional ways of serving food), researchers, local government, CSOs, NGOs, media, and artists.

The Fort Portal interventions stood out in having reached a large number of people (around 250,000), through a multitude of strategic avenues, targeting informal networks and influential community actors to promote nutritional education. This includes elaborate radio shows (such as broadcasting dramas and educational programmes) and public messages on nutrition. Religious, cultural, and community leaders were engaged as food ambassadors. Additionally, village health teams (VHTs), consisting of local volunteers trained in health and nutrition, were strengthened to conduct nutritional screenings, home visits, referrals, and community education and to enhance local nutritional knowledge.

The food safety approach implemented by Fort Portal FSL emphasized participatory, collaborative governance involving street food vendors, local authorities, and civil society. A vendor's cooperative, SACCO, and a Nutrition Coordination Committee were established, through which it was possible to organise capacity building, co-create training sessions and joint inspections, and help to improve hygiene, operational resilience, and compliance with safety standards. The key to working with informal street food vendors was the building of trust and the potential empowerment through advocacy as an organised group of 200 vendors, thereby enhancing local food governance.

4.3.3. Outcomes and Impacts

Fort Portal FSL's interventions resulted in significant benefits in terms of food and environmental enhancements. The active engagement of influential community actors and regular broadcasts through local media channels resulted in heightened community awareness and better nutrition-related practices. The proportion of respondents with adequate nutritional knowledge rose from 75.4% at baseline to 81.9% at endline and respondents who were confident in preparing a diversified diet meal rose from 36.2% to 46.5% (Annex 1). Over 1,400 VHT volunteers were trained, substantially improving local capacity for nutritional assessment, education, and management. For women, MDD-W increased from 29.5% to 34.9%, and for children, MDD-C increased from 25.9% to 37.3%. The share of households with vegetable gardens notably increased from 23.2% to 39.2%, directly influencing household nutritional diversity and resilience. Although not part of the original project design, religious institutions such as the Uganda Muslim Supreme Council contributed to food and nutrition security through initiatives such as fruit-tree planting campaigns. As trusted institutions, they also played a significant role in nutritional education campaigns, particularly after engaging and training imams and priests on the importance of improved nutrition for a healthy life.

The co-creative and empowering approach to food safety in Fort Portal FSL is an example for many other African cities. After initial mobilisation and organising, vendors reported that they currently have a bigger and stronger advocacy platform than before. The vendors' cooperative, SACCO, enabled many vendors to resume their businesses after the Covid-19 pandemic, when most businesses had to remain closed. These vendors themselves have become empowered agents of change, promoting food safety and hygiene, such as the promotion of clean cooking oil, proper waste management, fresh vegetables, and handwashing. The association's leadership is now embarking on advocacy for the consumption of safer and healthier food, fostering a sustainable street food industry within Fort Portal City and the hinterlands.

The FSL has been very successful in advocacy for local government endorsement and support, establishing nutrition coordination committees at district, city, and sub-county levels. Capacity-building activities and strategic meetings led to critical decisions, such as developing the Fort Portal Food Safety Ordinance, formulating nutrition action plans, allocating government-sponsored radio airtime for nutrition awareness, and establishing a biodegradable waste recycling plant.

4.3.4. Lessons and Insights

The Fort Portal case demonstrates an integrated approach of mass media outreach with strategic stakeholder engagement, close government involvement, and direct collaboration with informal food system actors. It highlights how informal practices and self-organising social systems can be harnessed effectively through deliberate, yet flexible, external interventions. Nutritional improvements in the Fort Portal FSL have not only emerged from formal programmatic interventions, but also through the daily social practices embedded within community networks and interactions. Informal markets, religious gatherings, and radio broadcasts serve as critical spaces (or "sites") where nutrition practices are shaped and reshaped. These informal spaces, not all typically part of the food environment, became instrumental as they leveraged existing socio-cultural trust and networks, enabling widespread dissemination of nutritional knowledge and promotion of behavioural change (Banks et al., 2020; Roy, 2005).

The nutritional messages disseminated by religious and cultural leaders exemplify a shift from loosely connected informal practices towards a more collective, community-driven approach. VHTs further illustrate the self-organising capacity as they integrate community trust with systematic nutritional monitoring and education, operating effectively despite irregular and limited external supervision. The voluntary engagement and organisation of informal street food vendors into an association illustrates how informality can be self-organised and empowering, enabling active participation in formal governance structures to advocate for their needs and gain recognition for their contribution to providing more nutritious and safe food to the public.

4.4. Cotonou FSL, Benin

Cotonou, Benin's largest urban area with around 670,000 inhabitants (INSAE, 2013), faces severe food and nutrition challenges in its peri-urban communities. High poverty and food insecurity mean that many families struggle to afford a healthy diet and only about 18% of households are food secure. These conditions have severe impacts on children: roughly 36% children under five in Benin suffer chronic malnutrition (WFP, 2024b). Simultaneously, overweight is emerging among school-age children. In response, the government launched a National Integrated School Feeding Programme (PNASI, supported by the WFP) to provide daily meals in public primary schools and improve child nutrition and educational outcomes (implemented among both intervention and control groups).

4.4.1. Key Food System Characteristics

The school food environment around Cotonou's schools constitutes a hybrid of formal and informal food provisioning. Formal school canteens provide thousands of children daily with a structured meal, typically rice or maize porridge with beans. This regular meal is crucial for students' nutrition but often limited in diversity and rarely includes vegetables or fruit due to cost considerations and seasonal availability. On the other hand, schools are surrounded by small-scale food vendors and street stalls, representing an informal food environment where children buy additional food such as fritters, grilled corn, or sweet drinks. These informal vendors are key to food access for many students (and teachers), offering convenient and affordable options, but these foods are often energy-dense and nutrient-poor. Thus, children's diets combine formal canteen meals and informal snacks, both providing little dietary diversity. This dependency on low-cost, low-nutrient food reflects broader urban dietary patterns in Cotonou's peri-urban areas, where poverty and unstable incomes constrain food choices. Also, school meals and available local supply of fresh produce are disconnected due to centralized feeding programmes and external aid.

4.4.2. FSL Interventions

The Cotonou FSL, led by the University of Abomey-Calavi and the Alliance of Bioversity International and CIAT, co-created and implemented a suite of interventions to transform the school food environment through urban agriculture and nutritional education. The FSL engaged a wide range of local stakeholders, including teachers, parents, urban farmers, and municipal authorities, in designing context-specific solutions.

Three interconnected interventions were implemented. First, school gardens were established in two public primary schools to supply fresh fruits and vegetables to school canteens and serve as living classrooms for

nutritional education. School teachers and canteen cooks were trained in sustainable gardening techniques and management. Pupils actively participated in operating the gardens, introducing practical agricultural skills into their curriculum. Fresh produce from the gardens was used in preparing school meals, diversifying the menu with fresh ingredients, while surpluses were shared or sold within the community.

Second, weekly nutrition education sessions were conducted for approximately 1,500 school children, as well as teachers, canteen cooks, and some parents. These sessions, led by nutritionists and trained community volunteers, used customized education tools to teach the importance of dietary diversity and good practices in water, sanitation, and hygiene. The educational activities sought to build both knowledge and practical skills, fostering healthier eating habits at school and at home.

Third, Cotonou FSL fostered community engagement and value chain linkages to support sustainable food provisioning for the schools. Over 100 local fruit and vegetable value-chain actors, including urban farmers, traders, and cooperative members from Cotonou and neighbouring communes, were trained in improved production techniques and cooperative management to strengthen the supply of affordable, local produce. By linking these producers to the schools, the FSL encouraged a farm-to-canteen model that integrates informal urban farming into the formal school feeding system.

4.4.3. Outcomes and Impacts

Initial results from the Cotonou FSL are promising, demonstrating both quantitative improvements and qualitative learning (Annexes 1 and 2). Intervention schools saw marked improvements in dietary knowledge and practices among students. The share of students who could explain the concept of a balanced diet increased by 70% from the baseline, while it slightly declined in the control schools. Knowledge on different food groups also increased by 88%. Knowledge gains also translated into healthier behaviour: by the end of the project, fruit consumption was significantly higher in intervention schools, whereas it remained unchanged among control group schools. While overall DDS did not increase, intervention schools nevertheless performed significantly better than control group schools (Annex 1).

Teachers reported that pupils were more willing to try new foods (such as leafy vegetables from school gardens) and shared nutrition lessons with their parents and family at home. School canteen menus in intervention schools diversified by including vegetable stews and fruit servings a few times a week, a practice that was virtually absent before. Cooks and teachers reported greater confidence in preparing balanced meals after training (Annex 1). These findings align with similar studies in sub-Saharan Africa, which often report increased fruit and vegetable intake when gardens and education are combined (Deuri et al., 2021).

Beyond dietary metrics, qualitative insights emphasized the importance of community engagement and the challenges of sustaining change. The FSL's participatory approach proved critical for acceptance. School directors and parents' committees became enthusiastic supporters, viewing the garden and nutrition lessons as tools to improve children's wellbeing and performance. Bottom-up engagement thereby empowered communities to take ownership of food system innovations (Boonstra & Boelens, 2011). Many parents began home gardens or bought more vegetables after seeing their children's enthusiasm, indicating a positive spillover to household practices.

The Cotonou FSL also yielded policy-relevant insights. Integrating school garden and nutrition education with existing government programmes, such as PNASI, is beneficial and has enhanced the overall impact of the school feeding programme. However, policy support is needed to maintain such complementary initiatives, including funds for schools to maintain gardens and nutritional education. The Cotonou experience suggests that relatively low-cost, community-driven actions can generate significant gains in children's nutritional knowledge and diet quality, although long-term success will require institutionalizing these practices and addressing underlying socio-economic barriers.

4.4.4. Lessons and Insights

The Cotonou case vividly illustrates how food system change can emerge through shifts in everyday practices at the interface of formal institutions and informal community life. The social practices of school gardening, food preparation, and eating at schools are shaped by material tools, competences, and meanings. The Cotonou FSL deliberately targeted these three elements of practice: it altered material arrangements by creating school gardens, providing fresh produce and cooking equipment; it enhanced competences by training children, cooks, and farmers in new skills; and it reshaped meanings by instilling the value of diverse diets and healthy eating in the school community. By doing so, the FSL catalysed a change in the nexus of practices around school food provision and consumption. For example, the simple practice of a child eating lunch at school transformed from passively consuming a monotonous meal to actively recognizing the meal's components and nutritional value and even participating in growing the food in the school garden. This transformation exemplifies how the intervention bridged formal policy and informal community dynamics.

However, maintaining the school gardens requires ongoing resources (seeds, tools, watering) that put pressure on school budgets. There are also issues with watering during dry seasons and occasional theft of produce, issues requiring community vigilance and possibly external support. These observations underscore that knowledge alone is insufficient and that improvements in the school food environment should be complemented by broader poverty alleviation and food affordability measures (WFP, 2022).

Informal community efforts were organised to complement and enhance formal school feeding programmes reflecting principles of self-organisation in urban food systems (Boonstra & Boelens, 2011). Rather than top-down directives, the FSL facilitated a bottom-up process in which teachers, parents, and students co-created solutions, demonstrating community agency and adaptability. In sum, the Cotonou FSL case suggests that meaningful food environment transformations in African cities can arise from interventions that engage with the lived practices of communities. In this peri-urban school setting, sustainable change was co-produced by weaving together formal programmes and informal innovations, thereby contributing to healthier diets and a more resilient local food system.

5. Comparative Analysis

These four FSLs highlight different real-world experiences with food environment transformation in highly dynamic urban food system contexts. All of them focus on improving healthy diets and nutritional outcomes, generally through dietary shifts tending towards natural and plant-based foods (ALVs, legumes, fruits, benefiting health and dietary diversity, but also with positive environmental and resilience outcomes). Transformative changes in food environments are not pre-defined across different localities but represent

different transformative pathways co-developed with stakeholders in different real-world contexts facing specific food system challenges and conditions. In defining and co-developing specific transformative pathways, working with ToC as a tool for reflexive dialogue and defining a shared goal orientation on directions has been key (Blundo Canto et al., 2020).

Building on the ToC-based analysis (see methodological details in 3.2–3.4), each case was translated into a map of activities, outputs, and outcomes, which were subsequently clustered into a cross-contextual logical map (Figure 3). The implemented activities were grouped into common categories (production; market linkages; knowledge/education; governance and advocacy). Analysing the results through a social practice lens, three recurrent pathway logics emerge:

- (1) *Production-to-diet pathways*: School or homestead gardening and aquaculture pilots increase the materials available (fresh vegetables and fish), which, when paired with basic skills training, support changes in competences (growing, handling, and cooking) and meanings (valuing diverse and local foods), resulting in higher household or institutional dietary diversity.
- (2) *Knowledge-to-behaviour pathways*: Nutritional education (schools, radio, and community sessions) shifts competences and meanings around healthy choices; where affordable options are accessible, these shifts propagate through practice bundles to influence people's purchasing and cooking routines.
- (3) *Market/governance-to-access pathways*: Value chain linkages, food safety and governance measures (e.g., canteen hygiene, local ordinances, and inclusive governance on street-food vending), and local food policies alter socio-material and institutional arrangements that shape access (availability, safety, and affordability), enabling healthier choices to be enacted in daily practices.

The cross-case synthesis shows that combinations of these mechanisms underpin progress towards healthier, more sustainable diets. Figure 3 summarises these common impact pathways, derived from the clusters within the case maps. In short, transformative change was co-developed and path-dependent. Progress occurred when shifts in food provisioning, food acquisition, and lifestyle and community practices reinforced one another and when these practice bundles were supported by coordinated actions in production, knowledge, markets, and governance.

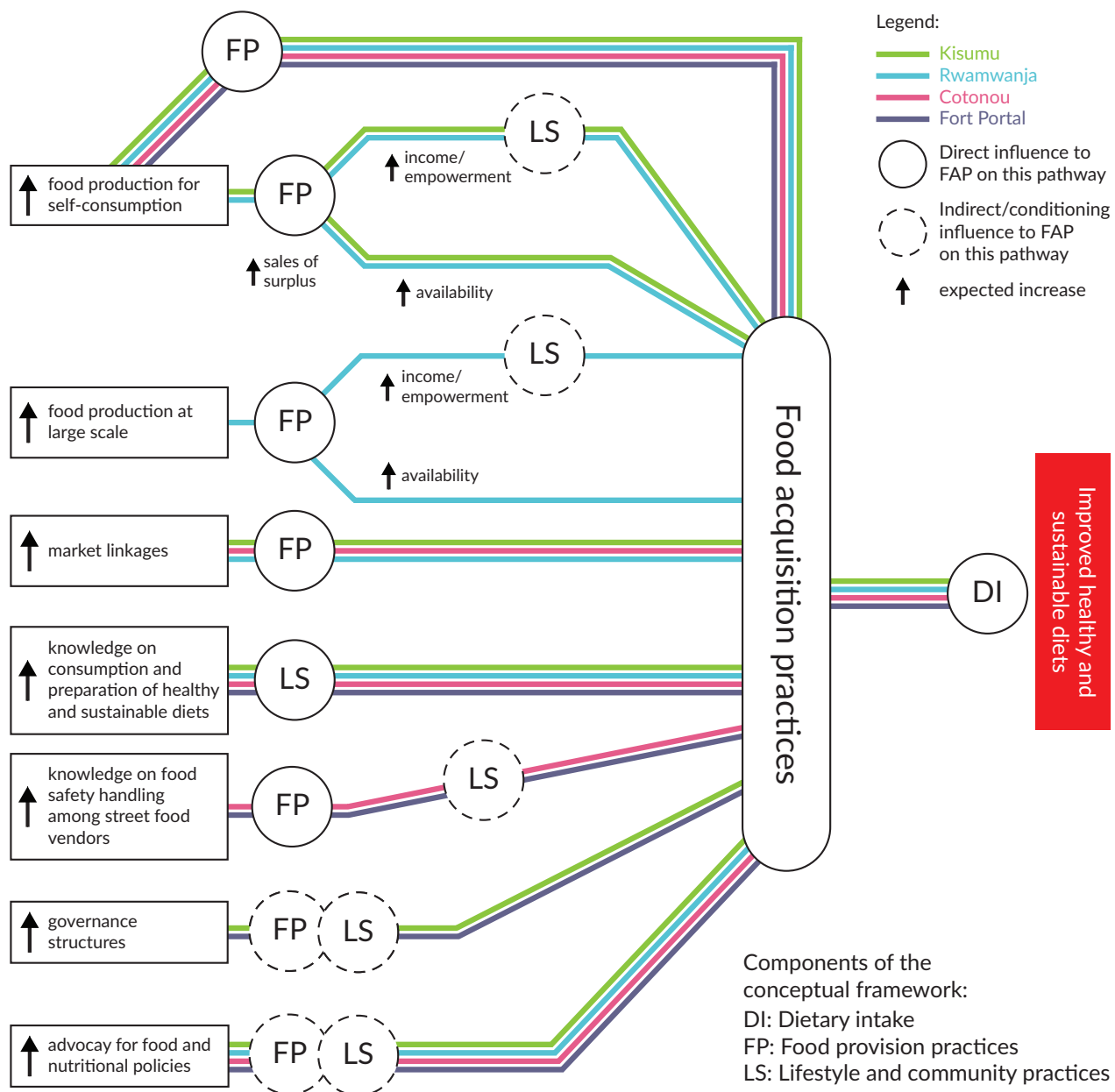


Figure 3. Common impact pathways across FSLs for improved healthy and sustainable diets. Coloured strands trace FSL-specific pathways; nodes mark contributing practice domains (FP, LS, DI). Solid = direct contribution; dashed = indirect/conditioning contribution, consistent with the framework in Figure 1 but applied to this pathway model.

6. Discussion and Conclusion

Insights into how bottom-up living labs, such as FSLs, function can help reframe our understanding of how to enhance food security and nutrition in the face of rapid urbanisation and climate challenges. Their relevance extends beyond nutrition and healthy diets and provides critical insights into the broader mechanisms of governance and the steering of sustainable food system transformations. FSLs operate as “living laboratories” in real-world settings, providing spaces of experimentation for transforming food-related practices and routines. Co-creating and co-developing these models with stakeholders (especially without

leaving urban poor consumers behind) ensures that their lived experiences are taken into account and avoids external interventions being imposed that do not fit local ways of living, routines, preferences, knowledge, etc. This also creates room for flexibility and adjustments where needed, in ways that cannot always be foreseen. Traditional top-down interventions frequently fail in highly dynamic food environments, where informality and self-organisation prevail (Leeuwis et al., 2021; Polese, 2021). A bottom-up approach does not guarantee success; however, it provides space for engagement and empowerment and gives stakeholders the right to try to work out a plan of their own, to fail, learn from it, and improve until it works, or start over from scratch. When there is no room for failure, little that is new can emerge, whereas innovation is urgently needed in Africa's low-income urban areas, where food security and malnutrition challenges continue to expand.

The FSL case studies show that informality is not a barrier but a resource for innovation and resilience. As a design principle, it helps navigate the messiness of urban food environments and the unruliness of food-related practices. For example, informal markets often respond rapidly to local changes in demand, and community networks have the capacity to mobilise and fill gaps in food provisioning, for instance by organising food sharing or offering informal credit during shortages. By embracing the complexity and unpredictability of informal urban food governance mechanisms, these bottom-up efforts may effectively enrich policy frameworks and help bridge the gap between bottom-up experimentation and formal governance structures (Boonstra & Boelens, 2011; Vorley, 2023). FSL experiences have also demonstrated how bottom-up arrangements may interact with traditional top-down institutional policies in productive ways. The implementation of food safety policies for street food vendors and hybrid school food approaches are cases in point. Effective collaboration occurs when top-down institutions recognise the value of local knowledge and the adaptability of bottom-up innovations, allowing both governance modes to intertwine and reinforce each other's strengths in addressing complex urban challenges (Watson, 2014).

Addressing the broad range of food security challenges also requires establishing structural forms of social protection to support the most vulnerable groups, who are barely able to survive within the same systems of informality. In addition, ensuring sufficient supply of adequate, nutritious, and safe food in rapidly growing cities remains a challenge (Battersby & Watson, 2018). This raises questions about the potential for enhancing food safety within informal settlements and improving the efficiency of food distribution by strengthening the self-organising capacities inherent in the informal sector (Vorley, 2023). While informal networks have the capacity to evolve into more structured arrangements, such as associations or cooperatives, this formalisation typically occurs alongside continuous new entries into informality due to persistent structural challenges of poverty, particularly among young people. It is important to recognise that informal food vendors themselves are predominantly urban poor, whose participation in the informal economy largely arises from the necessity to secure their basic livelihoods (Crush & Young, 2019). Enhancing vendors' capacities to self-organise and expand their businesses could potentially generate twofold benefits: improving their economic stability while simultaneously increasing local availability and accessibility of diverse, safe, and nutritious food (Skinner & Haysom, 2016). This aligns with findings from the "Sustainable Healthy Diets through Food Systems Transformation" initiative, demonstrating that strengthened informal supply networks can positively impact both vendors' livelihoods and urban dietary outcomes (Chege et al., 2023).

A more fundamental goal of living labs, such as FSLs, is to promote a shift in mindsets, empowering people and organisations to take action and ownership so that, when the next problem arises, they know how to

identify problems and where and how to seek solutions, instead of waiting for outside solutions to come in. PAR and co-learning effectively support beneficiaries as agents of change, rather than recipients of external aid. Several FSL experiences have demonstrated a capacity for self-organisation as a mechanism for food environment transformation. Another key factor identified in several FSLs is trust, which is crucial among stakeholders to commit and invest their time and energy in developing shared long-term strategies. Yet this trust takes time to build. The short project cycle of research and donor funding expects results and impacts within three to four years. This is often incompatible with the unpredictable dynamics and political complexity of multi-stakeholder processes.

A remaining challenge for researchers is to better capture these small but important “soft changes” and processes, including changes in narratives on the ground and among policymakers. For example, in the case of FSL Kisumu, the county government and stakeholders were initially unfamiliar with a food systems approach, but by the end of the project they were convinced of the need for such an approach, though still puzzled about how to organise and coordinate it at county policy level. This change of heart stems not only from the efforts of the HFA project but also from the interplay of various food system actors and initiatives coinciding in Kisumu. Together, these dynamics make the need for a coherent food system approach even more critical. How can we develop better tools to profoundly understand such incipient transition processes in practices and policies and support them with lessons learnt and effective policy recommendations? Insights from this article and the HFA project more generally indicate some promising avenues, but much more is needed to bring about a paradigm shift in how diet, health, and environmental outcomes can be transformed in highly dynamic food environments.

Finally, it is important to acknowledge the broader political-economic context as a limitation and conditioning factor for bottom-up governance approaches. Structural power imbalances persist, with large industrial players maintaining substantial influence over food system decisions and policy-making processes, often promoting unhealthy diets and unsustainable agricultural practices (Stuckler & Nestle, 2012). While local self-organising efforts can generate valuable grassroots innovations, substantial transformations also require policymakers to enact and enforce robust regulatory frameworks (Swinburn et al., 2019). Experience from Chile demonstrates that strong governmental regulations, such as restrictions on unhealthy food marketing and the introduction of sugar taxes, can significantly reduce non-communicable diseases (Taillie et al., 2020). Therefore, bottom-up innovations must be complemented by advocacy efforts that promote supportive regulatory frameworks and build the necessary political will to achieve lasting structural change.

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The authors declare no conflict of interests.

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Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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About the Authors



Ardjan Vermue is a food systems researcher and lecturer with international experience in sustainable agriculture and agroecology. Holding an MSc in Organic Agriculture, he explores the intersection between social and technical dimensions through participatory action research on agroecological transitions, focusing on smallholder farmers and wider food system transformations.



Henk Renting is a researcher and lecturer in urban food systems and food system innovation at Aeres University of Applied Sciences Almere, the Netherlands. He has over two decades of experience in national and international research projects on sustainable food systems, rural development, city region food systems, urban food policies, and short food supply chains.



Celine Termote is the Africa research lead in the Food Environment and Consumer Behaviour research program at the Alliance of Bioversity International and CIAT. She has two decades of experience designing and implementing research for development projects bridging ethnobotany, agroecology, market linkages, food environments, and diets, while embracing co-creation approaches empowering communities to collaborate towards inclusive, sustainable food systems.



Consolata Musita is a nutritionist and food systems researcher who focuses on nutrition-sensitive food systems by exploring the intersection between food system interventions and diets. She holds a BSc. in Foods, Nutrition and Dietetics, an MSc. in Food Safety and Quality, and is currently pursuing her PhD in Applied Human Nutrition.



Claudia Segreto holds an MSc. in Nutrition and Health from Wageningen University, with a focus on inclusive access to healthy food. She worked at Aeres University of Applied Sciences on sustainable food transitions. Currently, she is a private nutritionist, promoting healthy and sustainable diets while maintaining respect for traditions.



Sigrid Wertheim-Heck is associate professor of food system sustainability at Wageningen University, the Netherlands. As a sociologist, her research takes a localized perspective on socio-technical food system transformations and the relationship between urbanization, provisioning, and consumption, emphasizing bottom-up governance arrangements and how local practices interconnect with national and global dynamics.