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# Co-creative rapid assessment for actionable circular food systems

SPECIAL ISSUE
**Community-Based Circular Food Systems**

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## Abstract

This paper focuses on the use of rapid assessments for local food systems in eight African cities (Bamenda, Cameroon; Franceville, Gabon; Ibadan, Nigeria; Lagos, Nigeria; Moyamba, Sierra Leone; Nairobi and Nakuru, Kenya; and Tamale, Ghana). The INCiTiS-FOOD project (INtegrated and Circular Technologies for Sustainable city region FOOD systems in Africa) conducted a food systems assessment using a bottom-up and living lab approach to gain insights into the local potential for circular technologies centered around aquaponics, hydroponics, and insect farming. The findings allowed us to define a strategic direction and highlights the need for more fish and locally grown indigenous vegetables, as access to these disciplines has been limited by a lack of knowledge facilities and finances. We learned that co-creative rapid

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assessments are a promising method to raise awareness of the specific opportunities, challenges, and bottlenecks in the community, and to align the local community with actionable food system transformation.

**Keywords**
aquaponics, fish, food production, healthy food consumption, African food systems, hydroponics, insect farming, rapid assessment, re-circular aquacultural systems (RAS), vegetables

## Introduction

The INtegrated and Circular Technologies for Sustainable city region FOOD systems in Africa project (INCiTis-Food) establishes city region food living labs for circular technologies centered around aquaponics, hydroponics, and insect farming (https://incitis-food.eu/). These are located in eight African cities (Bamenda, Cameroon; Franceville, Gabon; Ibadan, Nigeria; Lagos, Nigeria; Moyamba, Sierra Leone; Nairobi and Nakuru, Kenya; and Tamale, Ghana) in close relationship with academic competence centers to address local food system challenges. These challenges encompass environmental degradation (Subramaniam & Masron, 2021), the need for food security in a growing population (Riggs et al., 2018), and health-related concerns (Lindgren et al., 2018). There is insufficient evidence on the level of peri-urban food region to support the wider use of circular technologies as a response to unmet community needs in food systems (Carey, 2017; Deconinck et al., 2021; Fanzo et al., 2020, Galea et al., 2019). We addressed this gap with a co-creative rapid assessment. The main research question of this paper is whether the use of co-creative rapid assessment approaches can contribute to the strategic direction of consumption and production systems in the community, and whether the assessment approaches provide sufficiently reliable information to guide living labs engaging in local food systems transformation. Living labs are a relatively new scientific research approach. They are based on open innovation ecosystems and user-centric needs evaluations. They are a systemic co-creation process in real-life communities (Higgins et al., 2011) and have, therefore, similarities with rapid assessment. The use of co-creative rapid assessment provides an efficient way of rapidly collecting information about a community's direction, paired with a mechanism to support innovative engagement and innovation to support the establishment of community-based living labs.

## Literature Review

The use of rapid assessments for food systems was first suggested by Borman et al. (2022) as a response to the 2021 UN food systems summit. Rapid assessment refers to a quick and efficient process of evaluating a situation, condition, or environment to gather essential information and make informed decisions. Rapid assessment methodology is based on expert opinions rather than sample surveys. Recently, it was applied to minimize the impact of environmental disruptions (Legge et al., 2022), to evaluate the effect of COVID-19 on African seed sectors (de Boef et al., 2021; Villasante et al., 2021), to formulate a national response to pollution (Royle et al., 2022), and for evaluating development programs (Pearson & Kessler, 1992).

Rapid assessment is a mixed methods approach; in our case, it combines expert elicitation (Brown, 1968; Dalkey & Helmer, 1963; Linstone & Turoff, 1975; Sackman, 1974), opinion ratings (Likert, 1932), visualization via heat maps (Food Systems Dashboard, 2023) and focus group discussions. Tsusaka et al. (2015) successfully showed that expert elicitation results regarding agricultural technology adoption were better suited and more precise than data obtained from household studies for strategic decision-making. Rapid assessment is a cost-effective and time-efficient approach (Pearson & Kessler, 1992); however, it requires a lot of care and preparation in the use of different qualitative and quantitative tools (Cernea, 1992). Rapid assessment methodology is considered suitable for building alliances between community groups (Stimson et.al., 2009). The drawbacks are the lack of a supportive decision-making apparatus (Pearson & Kessler, 1992) and that rapid assessment might lead to premature decision-making regarding short- and long-term objectives, for example, balancing economic profit versus health aspects (Varker et

al., 2015). Rapid assessments are prone to cultural and political bias as well as anchoring. The results are usually of little use for long-term programs such as disease control or global food safety (Guha-Sapir, 1991), but they are important for living lab approaches that start directly from practice without an initial research phase (Gu et al., 2021; Herrero et al., 2020).

## Applied Research Methods

The Rapid Actionable Food Systems Assessment bases its approach on the work of Carey (2017), van Berkum et.al. (2018), Borman et al. (2022), and de Boef et al. (2021). It uses a mixed method approach combining expert elicitation, surveying, and visualization of opinions via heat maps (Food Systems Dashboard, 2023), followed by focus group discussions (Kraaijvanger et al., 2016; Tregear et al., 1998) to produce actionable results on a community level. It follows the steps of a value chain assessment (de Boef et al., 2021) including:

(1) a definition of the boundaries and the institutional setting, based on urban or value chain–based food systems approaches,
(2) identification of an expert and practitioner hybrid panel for the development and completion of a rapid assessment questionnaire,
(3) and visualization and discussion of results and validation of focus areas in focus group discussions.

This method was considered economically feasible and timely for the project, which required the delivery of results in just 6 months to inform the strategy of the living labs.

### *Step 1: Questionnaire*

In the first step, we used Carey's (2017) indicators for city region food systems evaluations to formulate the questionnaire for actionable food systems. Carey defined a dataset of local food systems indicators with the purpose to inform local policymakers on the performance of the local food system. The dataset requires the collection and monitoring of four categories of data on accessing healthy food and nutrition, improving social conditions of the workforce, building a local food culture, and creating parameters for an equitable food system for citizens from various backgrounds. A specifically formed panel of experts and practitioners then discussed the questions and agreed on the questionnaire. (The full questionnaire is in the Appendix.) Carey's urban food systems evaluation was targeted at policymakers and assumed access to city region household-level data and health data, which had not been available in the INCiTiS cities, or the local experts had ruled out cooperation with public authorities to get this information. It was also unclear whether available household, industry, and health data would provide a sufficiently reliable picture of the local situation after the pandemic. Therefore, questions were reformulated for this study and rated based on expert opinions.

### *Step 2: Panel*

We used van Berkum's (2018) food systems actor framework to identify local stakeholders for the expert and practitioner panel. This framework helped us to address a predefined number of topics in health, nutrition, trade, and industry relevant to food security and provided insight on the trade-offs with other policy objectives. It also identified various vulnerabilities in the food system and their impact on resilience to climate change (van Berkum, 2018). Finally, the extension of this framework toward gender-related vulnerabilities and empowerment (McDougall, 2021) made our approach fit for purpose. We added expertise where the stakeholder framework fell short; specifically, the project defined specific objectives, such as inclusiveness (Osorio et al., 2019) and examined market potential for fish, insects and vegetables. The hybrid expert-and-practitioner panel was formed from local representatives. It comprised 97 members from the eight cities. Three cities participated online from in-person meetings of 25 participants each. A minimum of six people from each stakeholder group were included in the panel, allowing for an adequate degree of representation in access to nutritious food, gender, policy, consumer matters, aquaculture, hydroponics, and insect farming as well as upstream and downstream

value chain representation. A particular effort was made to increase the number of women and young people in the panel through local and international nongovernmental organizations (NGOs) and associations such as Women Engage for a Common Future and Youth for Development. Participants used Miro boards, responded to online polls, and were provided the opportunity for reflection in the panel on provided inputs and specific research questions.

The panel met for the first time in May 2023 to agree on a questionnaire to inform the living labs. It then met again in July to discuss the answers, clarify outcomes, and define actions to influence the local community food systems. In the discussion of the questionnaire, the expert panel considered it imperative to collect additional information reflecting the informal economy. Therefore, additional responses from consumers and retailers at three different markets (one each in a high-income neighborhood, middle-income neighborhood, and low-income neighborhood) were collected by students from the participating universities. This increased the number of questions from 20 to 80 questions, making it necessary to introduce skip logic to direct questions toward the most relevant respondent groups, so that none of the respondents had to answer more than 20 questions.

### *Step 3: Answering the Questionnaire (Rating Opinions)*

Following the input from the expert panel, the questionnaire was finalized and disseminated through snowballing to include more food systems stakeholders and capture their views on the current situation in the city. Again, it is important to state that the aim was to agree on strategic actions, and not to sample representatively. Bias was mitigated by balancing the respondents according to the previously defined stakeholder groups and taking weighted averages per stakeholder group in the response rates. The survey was coded with Kobo Toolbox software using skip logic, so that none of the respondents needed to answer more than 20 of the 80 questions. Responses would otherwise have been too low, or the survey would have exceeded the capacity of the local internet, making it impossible for people to answer the questions. The students collecting additional responses received training, guidance, and information on the food system analysis methodology and the survey from the leading organization Wageningen University and Research and its local project partners. The survey was also promoted through social media posts and was accessible through an online link, which respondents could fill out either on a smartphone or another device. Table 1 presents the number of total survey respondents.

**Table 1. Survey Respondents**

| | BA | TA | NAK | IB | LA | MA | NAI | FR | Total |
|---|---|---|---|---|---|---|---|---|---|
| Consumers | 36 | 17 | 19 | 60 | 23 | 16 | 22 | 5 | 197 |
| Vendors | 7 | 5 | 3 | 28 | 12 | 12 | 33 | 1 | 101 |
| Researchers | 4 | 19 | 19 | 7 | 2 | 8 | 5 | 3 | 65 |
| Consumer organizations | 2 | 5 | 3 | 0 | 0 | 8 | 0 | 0 | 18 |
| Nongovernmental organizations (NGOs) | 4 | 10 | 5 | 1 | 2 | 6 | 0 | 0 | 28 |
| Farmer organizations | 5 | 5 | 6 | 4 | 0 | 4 | 2 | 2 | 28 |
| Governmental institutions | 4 | 9 | 13 | 1 | 5 | 8 | 3 | 6 | 46 |
| Input technology suppliers | 0 | 10 | 1 | 1 | 1 | 5 | 0 | 1 | 18 |
| Financial organizations | 3 | 7 | 4 | 5 | 5 | 5 | 0 | 0 | 24 |
| Processors | 2 | 5 | 10 | 1 | 1 | 9 | 0 | 1 | 29 |
| Total | 67 | 92 | 83 | 108 | 51 | 81 | 65 | 19 | 554 |

BA = Bamenda, Cameroon; TA = Tamale, Ghana; NAK = Nakuru, Kenya; IB = Ibadan, Nigeria; LA = Lagos, Nigeria; MA = Mayomba, Sierra Leone; NAI =N airoby, Kenya; FR = Franceville, Gabon; NGO = Nongovernmental organization

### *Step 3: Visualization of Results from Survey Responses and Validation of Impact Areas Through Focus Group Discussion*

The survey respondents rated the communities' food systems performance from *severely negative* to *highly positive* on a Likert scale from 1 to 5. Answering *neutral or not able to assess* was also one of the options. The information gathered was visualized in combined impact areas (Table 2) and heat maps. The heat maps showed the weighted average scores on a colored map using a traffic light system from red (very bad performance, challenging) to green (very good performance or opportunity) (Table 3). The indicators covered the ratings for several questions combined for different dimensions.

The heat maps showed color-coded scores defining the intensity of positive impact for each indicator and different stakeholder groups or sectors. Since respondents could also vote "I do not know," there were several blanks or research gaps in the results, which we noted as such.

The ratings in the survey ranged from 1 to 5, and the results used weighted averages. A higher number means that experts perceived the level of equality in the food system more positively. The empty cells mean that the Bamenda local team could not provide

**Table 2. Impact Areas of INCiTiS-FOOD Systems (FS)**

| Impact areas | Indicators give insights into: |
|---|---|
| **Socially sustainable FS** | (1) Stakeholders' perception of **healthy diets** for all, with a focus on the overall ability of the city to provide healthy nutritious food for all.<br>Answers have been integrated into four indicators:<br>• accessibility<br>• affordability<br>• availability of healthy nutritious food to all<br>• food security<br>(2) **Food governance** as an enabler of FNS and channelling retail influences. They focus on policies and regulations to promote<br>• health and well-being<br>• equitable and just decision-making<br>• accountability and monitoring<br>• the health consequences from exposure to unsafe food<br>(3) **Equitable outcomes** for<br>• men and women<br>• young people<br>• consumers buying from informal markets |
| **Environmentally sustainable FS** | (1) **Protecting resources by reducing:**<br>• food waste<br>• recycling<br>• food loss<br>• hazard elimination<br>(2) stakeholder's perception of the **effectiveness** of policies for:<br>• environmental governance for circularity<br>• stewardship of environmental resources |
| **Economically sustainable FS** | Opportunities for entrepreneurs and innovators regarding:<br>(1) **Market potential** of new technologies in terms of<br>• competition<br>• access to inputs<br>• supply and demand of produce<br>(2) **Value chain development** in terms of<br>• linkages and connectivity for addressing FS change<br>• sustainable employment<br>(3) **Decent jobs** with a focus on the quality of employment in terms of<br>• equality<br>• influence<br>• inclusion and diversity<br>• career opportunity<br>• attractiveness of jobs<br>• job security in the new production and business area<br>(4) **Resilience and income** in terms of<br>• access to knowledge<br>• access to finance<br>to overcome barriers and develop business models that secure an income. |

information from input providers such as fertilizer manufacturers or aquaponics manufacturers. Empty cells are also a result of the skip logic used to reduce the number of answers per participants. For example, we did not ask consumer organisations about equal opportunities for farm employees. Experts could also make no ranking when they did not know.

Based on the outcomes of the survey, the supporting or contradicting literature, and the subsequent validation of the expert panel members, the team provided briefs on the performance of each city region's food system. To verify results, we used triangulation with national and international nutrition, household, and income studies such as national business studies (Business in Cameroon 2023), the Global Nutrition Report (2022), and World Bank (n.d.). The expert panel also submitted studies to support the survey results.

After evaluating the results together with the experts, the expert and practitioners panel met again in July to reflect on the results and to select the three most important impact areas per city. For those impact areas, actions were defined to enable a smooth integration of circular technologies into the city food region. The discussion groups could use a Miro board to outline their actions. The WR team summarized the responses and triangulated them with literature from general sources and sources provided by experts. The experts reviewed the responses and tried to interpret them. Together, we defined the three most important impact areas per city and discussed what actions the living labs should prioritize to ensure the successful introduction of circular technologies in their cities.

## Results

Overall, the results from the rapid assessment showed potential for the introduction of aquaponics, hydroponics, and insect farming units in all communities. There was a clear need for more fish provided in all cities and an even greater need for indigenous or locally grown vegetables. While consumers and experts, particularly women, saw a greater need for vegetables, young people, men, producers, and retailers saw more economic potential in providing fish. Thus, the combination of both technologies would provide a better balance in the city food region. Lack of access to financial aid and educational and knowledge facilities in the region were perceived as the main bottlenecks to the introduction and access to high-quality jobs in these disciplines.[1]

Some results were more controversial. While

**Table 3. Example Heat Map: Stakeholder Perception on Social Equity in Bamenda**

| | Consumer organizations | Farmer organizations | Financial organizations | Governmental institutions | Input/technology providers | Other NGOs | Processors | Producers | Researchers | Consumer rganizations | Traders, etc. | Vendors | Weighted average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Food safety | | | | | | 3.00 | 2.00 | 1.56 | 3.00 | 1.67 | | | 2.24 |
| Inclusion | | 2.67 | 3.83 | 4.13 | | 3.13 | 3.00 | 2.72 | 2.63 | 2.17 | | 3.79 | 3.12 |
| Infrastructure | 2.50 | | | 4.00 | | 4.25 | | 3.58 | 3.50 | 2.33 | | | 3.36 |
| Participation of women | 2.50 | | | 2.00 | | 3.00 | 3.50 | | 3.50 | | | | 2.90 |
| Participation of youth | 2.50 | 3.20 | 2.67 | 2.80 | | 2.50 | | 3.04 | 2.33 | | 2.92 | | 2.74 |
| Presence of informal business | 3.00 | | | | | | | | | | 4.06 | | 3.53 |
| Processing | | | | | | | 2.00 | 1.56 | | 1.67 | | | 1.74 |
| Production | | | | 3.00 | | | | | | | | | 3.00 |
| Retail | 2.75 | 3.08 | 3.83 | 3.43 | | 3.19 | 3.25 | 2.77 | 3.19 | 3.67 | 3.49 | 3.41 | 3.28 |

The weighted average scores (1–5) are displayed using a traffic light system, with red (very bad performance, challenging) to green (very good performance or opportunity).

[1] The full results of the food systems assessment will be displayed after acceptance of the report by the European Commission at https://INCiTiS-Food.eu

prospects for young people were perceived negatively, particularly in Kenyan cities, young people in Tamale stated opposite expectations, opening a pathway for cross-community learning.

The following is a description of the selected impact areas and recommendations per city. Challenges, opportunities, bottlenecks, and research gaps were identified based on the survey results. The community-level experts and practitioners then selected certain challenges and opportunities and identified actions based on these results. They could also choose to work on research gaps when information was not provided, not known, or needed more elaboration. As this was a co-creation process, the authors did not draw conclusions but merely visualized and summarized results and reported actions agreed on by the local communities in the second expert and practitioner panel meeting.

### *Bamenda*

The survey results confirmed by international household nutrition studies for Cameroon show that Bamenda faces challenges related to healthy diets such as the access and affordability of healthy food, and also related to non-inclusive food policy-making. Local stakeholders agreed to take action to increase the awareness about healthy diets and mobilize relevant stakeholders, such as through joining the Milan Urban Food Policy Pact. Low awareness and low governance, along with few policies on circularity and recycling in the city, are challenging for local actors. Stakeholders believe there are many opportunities to eliminate hazards from food waste, which should be systematically explored. There were also concerns regarding the access to and availability of inputs, knowledge sharing, and lack of services. Experts agreed on the use of training and flyers to increase collaboration across disciplines and to increase business potential. With the proper development of cooperatives, especially cooperatives of women, the business potential can be strengthened. The career attractiveness of aquaponics, insect farming, and hydroponics for women and youth in this area is well rated by experts and considered a major leverage for positive change.

### *Franceville*

Experts rated food security in Franceville as being low, with the lack of access to affordable healthy diets and the high presence of informal markets providing challenging conditions. If well exploited, the living labs' newly created production units and education courses can provide an avenue for opportunities, as they provide small-scale food options close to consumers and have the potential to improve formal business structures, which then can enhance access to finance. For developing the value chain, more information on age and gender structures in the current sectors for fish, vegetables, and insects should become available to target information, which is currently undetaken through GESI surveys. Identifying local value streams is important for governance approaches in the city.

### *Ibadan*

Ibadan's experts identified awareness of dietary requirements and availability of evidence-based information on circular production technologies an opportunity to be explored. Waste management could be transformed through local collaborations, which also will identify waste streams in the city with additional research. Insects are a low-cost protein source that could be better exploited by moving insect farms closer to the city. Also, business model analysis and low-cost start-up constructions can be developed to model the potential of new technologies and demonstrate urban farming alternatives to farmers in the vicinity. The promotion of new technologies is targeted at women and young people to circumvent current land access issues with soilless farming alternatives.

### *Lagos*

In Lagos, a major bottleneck for aquaponics farmers is the shortfall in knowledge, finance, and access to land and services. Enhancing access to start-up capital for women and young people can support the already well-perceived job and career opportunities for women in aquaponics, aquaculture, and, in particular, vegetable production in the city. It is recommended to research the opportunities for more integrated value chain finance and a well-developed enabling environment in the city. The main activities focus on developing structures

or platforms where practitioners can seek advice and demonstrate the potential of circular technologies. Environmental sustainability and market potential can be strengthened with effective waste management through proper education and knowledge sharing. Stakeholders should capitalize on the perception that insect farming is seen as a game changer in Nigeria.

### *Moyamba*

Moyamba experts believe that urban soilless food production can alleviate major challenges in affordable food, overfishing, and depletion of soils around the city. Since a large proportion of food is imported, there is particular demand for local vegetables, and increasing the use of indigenous vegetables can address the overall low vegetable consumption in the city. As a result, this can improve awareness and further push for the development of production facilities. With the government interested and engaged in enhancing circularity and waste management, there is a good prospect for circular technologies. The vegetable and fisheries sectors are the most promising in terms of youth engagement. However, more effort should be given to research and knowledge sharing on issues such as land prices. There is also the need to strengthen the enabling environment with more efficient services and to boost market linkages.

### *Nairobi*

Nairobi's actions focus on changing the perceptions of healthy foods in the urban environment. The change is already supported by good diversification of food sources and increased awareness. Food policies to ensure an efficient, enabling environment are also in place. Increased communication and market research for circular technologies are seen as great avenues to further engage stakeholders in the food system, for example, through the living lab. Building a network of investors and entrepreneurs to further increase the business potential of circular technologies, especially in the fish value chain, could enhance financial support, education, and market readiness among value chain partners, in particular young farmers and women in the city.

### *Nakuru*

In Nakuru, recent policies have strengthened the consumption of healthy food, building on the high availability of healthy dietary options. Environmental hazards, waste management, circularity and food safety issues, however, remain underexplored and could help overcome obstacles in the fish and insect value chains. More focus on knowledge and information creation is necessary, as well as strengthening technical support and enhancing capacity building. Building a network of enterprises and investors with an increased focus on financial access and inclusion of women and young producers can support business development in the city.

### *Tamale*

More awareness and promotion of healthy diets and consumption patterns has the potential to increase the consumption of fish and vegetables and even insect farming in Tamale. Consumption in all three categories is considered low at the moment. Increasing consumption requires the proper implementation of food and nutrition policies by local authorities, raising awareness among consumers, promoting local insect-rearing technologies (specifically for caterpillars) and aquaponics technologies, and providing more start-up financing or public incentives. Given local circumstances, the living lab should adopt a strategic approach, prioritizing economic growth and decent jobs and increasing market potential through collaborations and cooperatives. Environmental sustainability, circularity, and food loss are also seen as potential leverage points for change, as there is growing interest in recycling activities.

## Discussion

This discussion section interprets our approach and compares it to other research. The choice of rapid assessment has implications for the results and the suggested use of this approach.

### *Context Strongly Shapes the Food Systems' Outcomes*

The integration of various food system assessment frameworks within this study serves as the cornerstone for achieving a comprehensive and insightful analysis of community-based circular food systems

in African cities. Situated within the broader context of our research objectives and motivations, this section delves into the significance of combining these frameworks and adapting them to the specific needs of our study.

Against the backdrop of major value chain disruptions in Africa following the COVID-19 pandemic, the INCiTiS-FOOD project aims to create inclusive and sustainable food systems in African cities. The COVID-19 pandemic made us more aware of the systemic vulnerabilities and led to a nuanced understanding of the complexities within African peri-urban food systems. The multifaceted approach to establishing agrifood technologies extends beyond the traditional boundaries of soil-based agriculture and food production and incorporates a wider spectrum of factors that influence food system outcomes.

The diverse range of food system assessment frameworks enabled us to draw upon their collective wisdom and adapt their principles to our specific context. For example, the methodology by Borman et al. (2022), combining food system and sector frameworks, helped in deep-diving into sector-specific information related to the fish, vegetable, and insect sectors as proxies for a yet non-existent industry (circular technologies such as aquaponics). Additionally, the incorporation of food system elements as guided by van Berkum et al. (2018) and the RUAF Food system framework for city food regions (Carey, 2017) provided a structured framework for our analysis. These elements helped us identify the most pertinent aspects of food systems to evaluate in each city. As a result, we tailored our assessments to each location's unique characteristics and priorities, ensuring that our findings would be relevant and actionable.

This integration was not a mere academic exercise but a strategic move toward actionable insights and co-creation processes. By comprehensively understanding the multifaceted challenges and opportunities inherent in community-based circular food systems, participating experts identified key leverage points for intervention on the city level in the second panel meeting and focus group discussion. This knowledge, rooted in the integrated frameworks, serves as a robust foundation for designing effective strategies and policy recommendations.

Our approach was further fortified by the inclusion of experts and practitioners who brought their domain-specific local insights to the table. This collaboration was crucial in bridging the gap between theoretical frameworks and the lived experiences of community-based circular food systems in African cities in a vacuum of empirical evidence. It allowed us to fine-tune the assessment process, ensuring it remained grounded and capable of addressing real-world challenges.

The integration of these frameworks offered us a comprehensive lens through which to view peri-urban food systems. We scrutinized governance structures, examined food production techniques, assessed market dynamics, considered environmental sustainability, evaluated social equity, and explored numerous other dimensions. For example, gender experts expressed general discontent with local food systems policies and employment policies, which could be addressed on the living lab level. This can be achieved by providing information to local leadership on the opportunities for women and youth employment and demonstrating examples of best practices for inclusive work conditions. This integrated approach enabled us to gain a nuanced understanding of the intricate web of factors influencing food system outcomes.

In conclusion, the integration of food system assessment frameworks was not merely a methodological choice but a fundamental addition to sector analysis and to unraveling the local intricacies of peri-urban food systems in African cities. This approach allowed us to transcend the limitations of a one-dimensional analysis and provided us with the tools to offer actionable insights aimed at enhancing food security, environmental sustainability, and social inclusion within evolving peri-urban landscapes.

### *The Use of Co-creation Techniques Helped to Build the Ecosystem*

Our approach of using an expert and practitioner panel to reach a consensus on actions for the strategic development of the living labs can be described as co-creative. All experts were involved in the entire process of knowledge creation. Fur-

thermore, established contacts are useful in the follow-up of the project for onboarding participants in the living labs. The process was more participatory than a policy evaluation of city-level health and household data would be. The results were generated and developed together with other parties (Ind & Coates, 2013). In effect, the approach involved a diverse array of stakeholders, ranging from local academic and sector experts to supply chain actors, government representatives, and financial sector participants. Their inclusion was pivotal in ensuring a holistic analysis. The participatory nature of our approach, which began with co-creation sessions and workshops, allowed food systems actors to actively shape the research agenda, from agreeing on the questions they would answer to rating different challenges and defining recommendations and actions. This collaborative process enriched our study, ensuring that research objectives were aligned with practical needs and concerns.

Our consortium partners who specialized in gender and informal-sector perspectives contributed to a nuanced understanding of community-based circular food systems, which policy evaluations often omit. Women farmers in the panel could effectively give us a clear picture of how women collaborate differently in business than men, namely in women fishery collectives as opposed to single-owned male farming operations. An informal leader from the slums in Nairobi could explain to us how new technologies are implemented by women and how produce is supplied to local consumers. The engagement of experts with specialized knowledge in these domains underscored the importance of addressing gender dynamics and informal sector contributions within food systems transformation efforts.

Hybrid interactions, combining in-person and digital engagement, contributed to bridging the local technical divide and promoted inclusivity and collaboration among stakeholders. This approach transcended geographical constraints and encouraged stakeholders to take ownership of the local food systems transformation.

Beyond the immediate scope of our study, the engagement process contributed to building an ecosystem of collaboration among stakeholders, which is contributing in other ways to the project, for example in the onboarding of innovation actors in the living labs or in their contributions to other studies, such as the follow-up gender study that stakeholders are now willing to participate in. This ecosystem fosters ongoing dialogue, knowledge sharing, and coordinated action, creating a fertile ground for future initiatives aimed at enhancing food system sustainability and inclusivity. We try to nourish this ground through WhatsApp communication and various digital platforms through which the local living lab participants are knowledge exchange agents to the community.

Our commitment to inclusivity extended to the deliberate effort to involve vulnerable groups in expert meetings and co-creation sessions. Recognizing that marginalized populations, particularly women, young people, and those engaged in the informal sector, often face unique challenges and vulnerabilities within food systems, we prioritized and recognized their participation in the transformation process. Other project partners are continuing these efforts with additional research to fill the knowledge gaps revealed by this assessment and through projects with peer-to-peer support for women.

In the expert meetings and workshops convened to shape the research agenda, we proactively sought the insights of experts on gender dynamics and informal sector approaches. These experts played a crucial role in elevating the voices and concerns of vulnerable groups within peri-urban food systems. Their perspectives provided a nuanced understanding of the specific challenges faced by these marginalized communities, such as limited access to resources, market opportunities, and decision-making power. A simple example is that participants in the FSA came into contact with the living labs that provided waste that was used as feed for insects. This made them aware of the value of recycling, and they started to negotiate on waste delivery with others.

### *The Lessons We Learned by Applying This Mixed Approach*

Our journey through the analysis of peri-urban food systems in African cities has been marked by valuable lessons that have enriched our under-

standing and approach. In this section, we reflect on the key lessons learned during this study.

*Complexity of food systems reduced through expert ratings and visualization of results*

By integrating multiple food system assessment frameworks and tailoring them to the specific contexts of each living lab, we were able to navigate the intricate web of interdependencies within community-based circular food systems. Moreover, the visualization of results through heat maps helped to identify straightforward trade-offs and synergies identified in the systems. This approach allowed us to identify distinct impact areas for each living lab, recognizing the uniqueness of their challenges and opportunities. However, this process also highlighted the need for flexibility and adaptability in food systems analysis, as one size does not fit all.

*Quality of information: Representativeness, usefulness, and timing*

The quality of the information gathered during our assessment was critical to our study's success. While our engagement with diverse stakeholders enriched our data, questions arose about the representativeness of the data and whether expert elicitation would indeed give us equivalent results to empirical analysis. We grappled with the question of how representative the input received was for the broader community and for vulnerable and marginalized groups. Additionally, assessing the usefulness of the data was an ongoing process, as its value became more evident during the analysis and synthesis stages through the triangulation with literature. Timing was another consideration, as the rapid nature of the assessment demanded efficient data collection without compromising depth.

*Gender, vulnerable groups, and age data*

One notable lesson was the project's need for more explicit attention to gender and vulnerable groups within our analysis. While we sought to be inclusive in our engagement process by asking specific questions related to gender and vulnerable groups, we did not specify gender and vulnerable group markers within the survey population. As a result, we could not cross-reference responses to gain insights and verify whether gender and age dynamics were addressed properly by the survey respondents. This oversight highlighted the importance of collecting disaggregated data in future assessments to better inform interventions on the living lab level. However, we ensured that gender was a main focal point in the multidisciplinary FSA through gender experts and women practitioners who had equal weight in the selection of questions and impact areas as well as in giving their expert opinions. If we had excluded them, we would not have known what questions to ask. The survey results did not depend on the number of responses from men and women experts and practitioners in the community but on the agreement of all experts on the impact that addressing these issues has for the local community, as well as their contribution to actions related to inclusive conduct and representation.

These omissions raised questions about whether our approach adequately addressed the unique challenges and opportunities faced by women and other vulnerable populations within community-based circular food systems. We do believe that this was the case, as valuable insights on how the sector could support or hinder these groups were gathered, discussed, and included in final recommendations.

*Challenging assumptions about food systems*

Our engagement with practitioners and experts challenged underlying assumptions about food systems. We encountered instances where traditional policy assumptions were questioned by those actively engaged in food systems transformation. For example, in Tamale, policymakers and consumers saw greater value in fish than vegetables as contributors to the protein transition and to economic development. From the literature and the discussion of the results in the expert panel, stakeholders agreed that they were misinformed, that fish consumption was already higher than expected in a balanced diet and that the local market was especially in need of local vegetables and caterpillars. We considered it important to discuss the possible limitations of the methods we used with the main stakeholders of the project. This experience underscored the importance of maintaining an open and dynamic dialogue with practitioners, as

their real-world insights can challenge and refine theoretical perspectives.

In conclusion, our journey through this analysis of community-based circular food systems has been a learning experience that has deepened our understanding of the complexities, challenges, and opportunities within these dynamic landscapes. These lessons will inform our future research and engagement efforts, guiding us toward more inclusive, representative, and effective approaches to food systems transformation in African cities.

## Conclusions

The results obtained from our food system analysis for eight African cities were unique and distinct for each city. This highlights a fundamental aspect of our research: the inherent diversity and complexity of community-based circular food systems. Our approach challenged traditional, static models of understanding food systems and value chains. Instead of drawing direct comparisons between cities and stakeholder groups, we emphasized the importance of recognizing and appreciating their differences.

Moreover, our research has catalyzed action within these living labs to distribute more information specifically targeted at women, promote comanagement of living labs by both men and women, and increase access to finance and specifically enhance education and knowledge provision. There is currently an uptake of the recommendations proposed, reflecting a proactive response to the insights and challenges identified through our analysis. This demonstrates the practical impact of our research, not just in terms of academic contribution but also in tangible improvements in urban food systems.

However, a key lesson from this endeavor has been the transient nature of connections within community-based circular food systems. In fact, our approach relies on the use of expert knowledge and the availability of immediate, localized information. These elements are consistently accessible in urgent situations globally, provided that appropriate contextualization is applied. In the dynamic landscape of these systems, connections and collaborations, though crucial, can fade rapidly. This underscores the need and the importance for ongoing engagement and the nurturing of these relationships to ensure sustained impact.

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## Appendix. Questionnaire

### A. PERSONAL DETAILS

A1. If relevant, for which organisation do you work?
A2. To which area does your profession belong?
- a. Production
- a. Processing
- b. Logistics (storage, transport, trade)
- c. Food retail or catering
- d. Financial sector
- e. Extension services
- f. Policy
- g. Research

A3. In which sector are you involved?
- a. Vegetables
- b. Fish
- c. Insects
- d. Food in general
- e. Sector independent

A4. Are you an expert in one of the mentioned areas? Multiple answers possible.
- a. Gender
- b. Youth
- c. Aquaponics
- d. Hydroponics
- e. Insect farming
- f. No expertise

A5. In which country do you work or is your expertise based on?
- a. Cameroon
- b. Gabon
- c. Ghana
- d. Kenya
- e. Sierra Leone
- f. Nigeria

### B. FOOD AND NUTRITION SECURITY IN THE CITY

B1. How do you rate the ability of your city to feed its population now and in the near future (1–5 years)? (Food security)
B2. (Health and wellbeing and nutrition utilization)
B3. How do you rate the number of households in your city that reach the WHO dietary recommendation of consuming a minimum of 400 grams of fruits and vegetables per day? (Health and wellbeing and nutrition utilization)
B4. How do you rate the number of households in your city that reach the dietary recommendation of consuming 2 portions of animal products like meat, fish, or eggs per week?
B5. How do you rate the accessibility to a variety of food retail outlets located in or near to low-income neighborhoods that sell [vegetables/fish/insects]? (Accessibility)
B6. How do you rate the ability for consumers to access different types of food? (Accessibility)
B7. How do you rate the ability for women to access different types of food? (Accessibility/Gender)
B8. How do you rate the ability for consumers to afford buying food? (Affordability)
B9. How do you rate the ability for women to afford buying food? (Affordability)
B10. How do you rate women's decision-making on the expenditure of purchase food? (Affordability)
B11. How do you rate the importance of informal food markets for ensuring food and nutrition security in the city? (Informality)

B12. How do you rate the presence of food and nutrition policies in your region? (Food policy)
B13. How do you rate the implementation of food and nutrition policies in your region? (Food policy)
B14. How do you rate the presence of food safety policies? (Food safety)
B15. How do you rate the implementation procedure of food safety policies? (Food safety)

**C. SUPPLY CHAIN DEVELOPMENT**

C1. How do you rate the extent to which the city's [vegetables/fish/insects] supply chains are in place enabling consumers to access a diversity of local food outlets? (Chain diversity)
C2. How do you rate the participation/leadership of women within the [vegetables/fish/insects] supply chains? (Governance/inclusiveness)
C3. How do you rate the participation/leadership of youth within the [vegetables/fish/insects] supply chains? (Governance/inclusiveness)
C4. How do you rate to what extent social and gender norms affect participation of women in their specific function, positions and tasks in the [vegetables/fish/insects] supply chains? (Inclusiveness)
C5. How do you rate the linkage of producers in the [vegetables/fish/insects] to various buyers and markets? (Linkages)
C6. How do you rate the presence of registered businesses compared to unregistered businesses in the [vegetables/fish/insects] supply chain? (Informality)
C7. How do you rate the rules and regulations governing the [vegetables/fish/insects] sector? (rules & regulations)
C8. How do you rate the participation of [vegetables/fish/insects] supply chain actors in policy discussions relevant to the sector? (policy participation)
C9. How do you rate the level of existing infrastructure (i.e. roads, internet access, power) enabling [vegetables/fish/insects] supply chain actors to maximise their operations/practices? (infrastructure)

**D. PRODUCTION**

D1. How do you rate the access to land and secure ownership/tenure arrangements in the city for the production of [vegetables/fish/insects] ? (Access to land)
D2. How do you rate the cities' ability to produce a diverse range of healthy foods? (Production diversity)
D3. How do you rate the cities' capacity to produce [vegetables/fish/insects]? (Production capacity)
D4. How do you rate the appropriate and efficient use of inputs for [vegetables/fish/insects] production? (Inputs)
D5. How do you rate the access to energy for [vegetables/fish/insects] production? (Energy management)
D6. How do you rate producers' capacity to invest in inputs and/or improved practices? (Inputs investment)
D7. How do you rate women's capacity to invest in inputs and/or improved practices? (Gender/ Inputs investment)
D8. How do you rate producers' access to knowledge and skills? (Access to knowledge and skills)
D9. How do you rate women's access to knowledge and skills? (Gender/Access to knowledge and skills)
D10. How do you rate water management practices at production level? (Water management)
D11. How do you rate access to clean water at production level? (Water management)
D12. How do you rate the availability of labour for [vegetables/fish/insects] production? (Labour availability)
D13. How do you rate [youth/women] engagement in [vegetables/fish/insects] production (i.e., young people increasingly growing vegetables)? (Gender and youth inclusion in production)
D14. How do you rate the career attractiveness of working in the food system for [youth/women]? (Gender and youth inclusion in production)
D15. How do you rate the presence of registered businesses compared to unregistered businesses at the production phase? (informality)
D16. How do you rate the management or reduction of post-harvest losses at the production facilities? (post-harvest loss)

## E. STORAGE, PROCESSING, TRANSPORT AND TRADE

E1. How do you rate the ability for food processors to provide healthy, safe and sustainable [vegetables/fish/insects] products in the city? (Processing)
E2. How do you rate the reliability of [vegetables/fish/insects] supply in terms of volume? (food supply)
E3. How do you rate the ability for traders to provide healthy, safe and sustainable [vegetables/fish/insects] products in the city? (Trade)
E4. How do you rate the quality of [vegetables/fish/insects] supply regarding required or desired standards? (food supply)
E5. How do you rate the extent to which processing sectors comply with sanitation and food safety regulations? (Food safety)
E6. How do you rate the ability to safely store [vegetables/fish/insects] products in the city? (Storage)
E7. How do you rate the ability of the urban plan to support the safe movement of products from production areas to consumers? (Transport)
E8. How do you rate access to affordable and suitable (e.g., cold chain transport system) product transport services? (Transport)
E9. How do you rate access to formal financial services by informal value chain actors?
E10. How do you rate the presence of women in processing in the [vegetables/fish/insects] supply chains? (gender)
E11. How do you rate the presence of women in storage in the [vegetables/fish/insects] supply chains? (gender)
E12. How do you rate the presence of women in transport and trade in the [vegetables/fish/insects] supply chains? (gender)
E13. How do you rate the presence of youth in processing, storage, transport and trade in the [vegetables/fish/insects] supply chains? (age)
E14. How do you rate the difference between ethnic groups in being able to participant in supply chain activities? (Inclusiveness)
E15. How do you rate the presence of registered businesses compared to unregistered businesses in the processing, storage, transport and trade? (Informality)

## F. FOOD ENVIRONMENT AND FOOD CONSUMPTION

F1. How do you rate the consumption of [vegetables/fish/insects] at household level? (Household consumption)
F2. How do you rate the infrastructure for the city's food marketing, catering and retail for the [vegetables/fish/insects] products? (Market infrastructure)
F3. How do you rate the ability for food outlets to be tailored to the different needs of people based on individual factors (e.g., sex, age, ethnicity, religion)? (Inclusion)
F4. How do you rate consumers' acceptance of [vegetables/fish/insects] products? (Consumers' acceptance)
F5. How do you rate the awareness on the nutritional value of [vegetables/fish/insects] among consumers? (Consumers' awareness)
F6. How do you rate the presence of registered businesses compared to unregistered businesses for food outlets? (Informality)
F7. How do you rate the extent to which retail and catering sectors comply with sanitation and food safety regulations? (Food safety)

## G. WASTE GENERATION AND CIRCULARITY

G1. How do you rate the scale of food loss (produce loss in the supply chain before it reaches the consumer) in your sector [agriculture (vegetables, fruits & cereals), livestock (cattle, pigs, poultry) and aquaculture)]? (food loss)
G2. How do you rate the level of food waste (waste from households, restaurants and industrial waste) in your sector? (food loss)

G3. How do you rate the level of food loss and food waste being recycled (composting, biodigester, bio-incineration etc.) in your sector? (food waste recycling)
G4. How do you rate the level of food loss and food waste 'not' being recycled (landfill sites, incineration etc.) in your sector? (food waste recycling)
G5. How do you rate the efficiency of waste segregation (separation of plant and animal waste, dry waste, wet waste) in your sector? (waste segregation)
G6. How do you rate the process of eliminating hazards from food waste (for example; drying, boiling, blanching, acidification, fermentation and freezing) in your sector? (hazards from food waste)
G7. How do you rate the pre-treatment of residual organic streams (pasteurization, fermentation etc.) in your sector? (waste management practices)
G8. How do you rate the availability of land for circular waste management (biodigester, bio-incineration, insect farming etc) in your sector? (waste management practices)
G9. How do you rate the technology adoption of circular waste management in question 3.7 & 3.8 (pasteurization, fermentation, biodigester, bio-incineration, insect farming etc.) by existing businesses?
G10. How do you rate the technology adoption of circular waste management in question 3.7 & 3.8 (pasteurization, fermentation, biodigester, bio-incineration, insect farming etc.) by 'new potential businesses?
G11. How do you rate the business (cost-benefit analysis) of the waste produced in your sector (formal approach by institutes, for example by local municipality, companies etc.)? (waste management practices)
G12. How do you rate the business (cost-benefit analysis) of the waste produced in your sector (informal approach for example by farmers, consumers etc.)? (waste management practices)
G13. How do you rate the knowledge and information on the circularity of food loss and waste for the actors in the formal food sector(s) (national government, local municipality, supply-chain actors etc.)? (knowledge circular waste management)
G14. How do you rate the knowledge and information on the circulation of food loss and waste for the actors in the informal food sector(s) (farmers, consumers etc.)? (knowledge circular waste management)

## H. BUSINESS POTENTIAL OF HYDROPONICS, AQUAPONICS, INSECT FARMING, RE-CIRCULAR AQUACULTURAL SYSTEMS (RAS)

H1. How do you rate the current presence of different types of production systems in the city? (Business diversity)
H2. How do you rate the current business potential in [hydroponics/aquaponics/insect farming/RAS] in the city? (Business potential)
H3. How do you rate the competition between [vegetables/fish/insects] production and other farming systems (i.e., cereals or livestock) to various buyers and markets? (Competition)
H4. How do you rate the initial cost of investment/start up in [vegetables/fish/insects] production compared to other traditional systems? (Competition)
H5. How do you rate the access to formal and informal financial services by stakeholders (other than farmers) in [hydroponics/aquaponics/insect farming/RAS] sectors? (Services)
H6. How do you rate to what extent are these 'services' catering for the needs of women in their existing positions in the sectors? (Services - Gender Inclusiveness)
H7. How do you rate the availability of labour along the [vegetables/fish/insects] value chains (for activities other than production)? (Labour availability)
H8. How do you rate the access to information services (e.g., price, or market information, city planning) for [hydroponics/aquaponics/insect farming/RAS] sectors? (Access to information services)
H9. How do you rate the level and role of informality in determining the business potential for [hydroponics/aquaponics/insect farming/RAS] ? (Informality)
H10. How do you rate availability of energy supply (electricity) as a challenge to business potential in your region? (energy)
H11. How do you rate the availability of clean water supply as a challenge to business potential in your region? (water management)

## I. URBAN FOOD POLICIES

I1. Do you rate the presence of an active municipal government body that is concerned with food policies? (structure of government bodies)
I2. How do you rate the implementation of an active municipal government body that is concerned with food policies? (structure of government bodies)
I3. How do you rate the degree of multi-stakeholder representation in urban food policy making? (structure of government bodies)
I4. How do you rate the presence of assembling and analyzing urban food system data for monitoring and evaluation purposes? (structure of government bodies)
I5. How do you rate the implementation of assembling and analyzing urban food system data for monitoring and evaluation purposes? (structure of government bodies)
I6. How do you rate the presence of programs/policies that promote the availability of nutritious and diversified foods? (social sustainability)
I7. How do you rate the implementation of programs/policies that promote the availability of nutritious and diversified foods? (social sustainability)
I8. How do you rate the presence of food-related programs/policies with a specific focus on socially vulnerable groups? (social sustainability)
I9. How do you rate the implementation of food-related programs/policies with a specific focus on socially vulnerable groups? (social sustainability)
I10. How do you rate the presence of programs/policies that promote agricultural production and processing in the municipal area? (economic sustainability)
I11. How do you rate the implementation of programs/policies that promote agricultural production and processing in the municipal area? (economic sustainability)
I12. How do you rate the presence of programs/policies that specifically promote technologies like hydroponics, aquaponics, insect farming, or RAS in the municipal area? (economic sustainability)
I13. How do you rate the implementation of programs/policies that specifically promote technologies like hydroponics, aquaponics, insect farming, or RAS in the municipal area? (economic sustainability)
I14. How do you rate the presence of support services for the informal food sector (e.g., in the form of business planning, finance, and development advice)? (economic and social sustainability)
I15. How do you rate the implementation of support services for the informal food sector (e.g., in the form of business planning, finance, and development advice)? (economic and social sustainability)
I16. How do you rate the presence of programs/policies that address environmental sustainability (e.g., through more sustainable land use, the use of organic fertilizers, the promotion of mechanization)? (environmental sustainability)
I17. How do you rate the implementation of programs/policies that address environmental sustainability (e.g., through more sustainable land use, the use of organic fertilizers, the promotion of mechanization)? (environmental sustainability)