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Going with the food flow: The contribution of urban agriculture to a growing African city

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ABSTRACT

Sub-Saharan Africa's rapid urban growth is causing a decline in urban agricultural land, reducing access to healthy local food for citizens. This paper quantitatively and spatially describes the contribution of urban and peri-urban producers to the availability and accessibility of fresh leafy vegetables in the growing city of Dar es Salaam, Tanzania. Based on over 700 surveys with food vendors and consumers, as well as ethnographic research with farmers, we show how a total of 70 per cent of all amaranth consumed in Dar es Salaam was found to be produced within the city. With an average distance travelled from farm to fork of 11 km, leafy vegetables have a strongly localised foodshed. The results show the ongoing significance of urban areas in meeting their own food demands, emphasising the necessity to explicitly integrate food provisioning in the planning of growing African cities.

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Foodshed; urban agriculture; food security; urbanisation; amaranth; Dar es Salaam

1. Introduction

Sub-Saharan Africa's cities are rapidly expanding, reshaping landscapes and societies in a myriad of ways. Increasing poverty and inequality in cities as a result of unplanned growth pose disproportional food security challenges for economically marginalised groups. The urban poor, when compared to rural areas, are believed to be particularly vulnerable to food insecurity given the high dependence on the cash economy in cities (Battersby, 2011; de Zeeuw & Drechsel, 2015; Ruel et al., 2017). The (global) trade disruptions caused by the Covid-19 pandemic have shown that food insecurity increases due to income loss and rising food prices (Nechifor et al., 2021). The FAO's global study on Covid-19 found that urban areas with closer access to agricultural land (thus shorter supply chains) are more resilient to such food system disruptions (FAO, 2020). Nonetheless, food insecurity has long been viewed as a rural, production-based issue

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that is outside the mandate of city authorities (Crush & Frayne, 2011). As a result, food systems thinking is largely absent in the planning and policy of many African cities despite playing an important role in urban sustainability and resilience (Battersby & Watson, 2018b; Davies et al., 2021).

While local food production can contribute to urban resilience, much of the urban land expansions occur on agricultural land (D'Amour et al., 2017; van Vliet et al., 2017; Barthel et al., 2019). The expansion and densification of cities thus go together with the loss of agricultural land and the displacement of farmers; something which is often overlooked in African urban planning (Zoomers et al., 2017; Shannon et al., 2018). The impact of these processes on the availability and accessibility of food is largely unknown and may pose risks to food security. There is a resulting gap in understanding the contribution that urban and peri-urban farmers make to urban food security in Africa. By taking the food system of Dar es Salaam in Tanzania as a case example, the objective of this paper is to assess the contribution of local vegetable production to the food system. We do so by (1) quantifying the contribution of urban and peri-urban agriculture to the availability and accessibility of leafy vegetables in the city and (2) spatially mapping the food supply chain from production to consumption. We use the 'foodshed' concept as a way to geographically map the flow of food from producer to consumer, as if it were a watershed (Peters et al., 2009). Foodshed analyses have proven useful in studying the relationship between people (food) and place (shed) through a study of the flows of food from producer to consumer. However, especially in the Global South, where urban development is expected to have a major impact on both dietary patterns and land use, there has been limited research into the configuration and functioning of the city region foodshed (Schreiber et al., 2021; Hemerijckx et al., 2023).

The contribution of urban agriculture has generated considerable debate regarding its actual contribution to household food and nutrition security. As urban agriculture provides the most 'local' food to cities, the debate in the literature concerning its importance (Zezza & Tasciotti, 2010; Poulsen et al., 2015; Davies et al., 2021) somewhat mirrors the discussion surrounding the relative benefits of local versus global foodsheds. Proponents of urban agriculture point to its socio-cultural relevance (Battersby & Marshak, 2016; Olivier, 2019), economic opportunities for urban dwellers (Mensah, 2023), and contribution to food system outcomes such as food security (Maxwell, 1995) and dietary diversity (Poulsen et al., 2015; Warren et al., 2015; Hemerijckx et al., 2022). However, others argue that it provides a marginal contribution to food security, if any (Frayne et al., 2014, 2016; Davies et al., 2021; Riley & Crush, 2023), and that farming within cities cannot be the main focus of a sustainable strategy toward just, healthy urban food systems in low-income countries (Badami & Ramankutty, 2015). While it is acknowledged that (peri-)urban agriculture alone will not be able to feed entire cities or fulfil all household food needs, it may constitute a relevant and needed source of food to meet urban food demands. Aside from the debate for or against the continuation or further expansion of urban agriculture in African cities, this study responds to the need to quantify the status quo of urban agriculture and its contribution to the food systems of rapidly growing cities.

With a population rapidly approaching 5.5 million (NBST, 2022), Dar es Salaam in Tanzania is chosen as a case study to exemplify the growing number of large-sized cities in Africa where rapid expansion puts pressure on the urban food system. Urban

agriculture has been consistently present in Dar es Salaam over the past several decades (McLees, 2012; Wessels & Mgana, 2024). Because of its unique characteristics – including limited space, insecure land tenure, and proximity to markets – which distinguish it from rural agriculture, the cultivation of perishable vegetables is common in Dar es Salaam. This trend is similar to urban agriculture in many other African cities (Shackleton et al., 2009; de Zeeuw & Drechsel, 2015; FAO et al., 2022). The green leafy vegetable amaranth (*Amaranthus* spp., *mchicha* in Swahili) was selected for further study because of its prevalence and known health benefits. Leafy vegetables, as a side dish to starchy staple foods, are an important part of the traditional diet in Africa containing high nutritional value while being easily accessible and affordable, although their consumption is on a reported decline and is often associated with low social status (Gido et al., 2017; Mwadzingeni et al., 2021). Our analysis is specific to amaranth and indicative for leafy vegetables while simultaneously shedding light on the contribution that urban farmers make to the availability of healthy foods. Previous studies have shown that around 7 per cent of the total food requirements of Dar es Salaam are derived from local urban and peri-urban production (Schmidt, 2012), with 90 per cent of the city's leafy vegetables grown locally (Stevenson, 1996). Although these figures are popularly cited, the population in Dar es Salaam has tripled over the past three decades and a lot of former agricultural land has ceased to exist in its original form. This stresses the need for primary data to provide an in-depth understanding of the current foodshed, as well as to examine how food supply chains are changing over time.

We continue this paper by elaborating on the methods employed to study the foodshed of Dar es Salaam. Following this, we explore the city's foodshed by presenting the perspectives of consumers, vendors, and producers. While presenting these different perspectives, we quantify and spatially map the foodshed. We finish by reflecting on the study's limitations. In our conclusions, we summarise our findings and discuss implications for foodshed research and for practitioners who wish to incorporate food provisioning in the planning of growing cities.

2. Material & methods

This study quantitatively and spatially assesses the contribution of urban agriculture to the food system in an African urban context, using leafy green vegetables in the city of Dar es Salaam as a case study. The city is subdivided into five municipalities (or districts) which together constitute Dar es Salaam Region (Figure 1). All agricultural activities within this region can be considered 'urban', although we elaborate in several places on the particularities of these spaces. When referring to peri-urban areas in this paper, we broadly refer to the outskirts of the city towards the region's border where the landscape consists of a mix of urban and rural land uses and livelihoods.

2.1. Data collection

To provide a better understanding of the present-day foodshed of Dar es Salaam, a current primary dataset is needed that can provide information beyond outdated quantifications on the significance of urban agriculture (e.g. Stevenson, 1996). Stakeholder interviews and three rounds of surveys (by the first author, supported by three

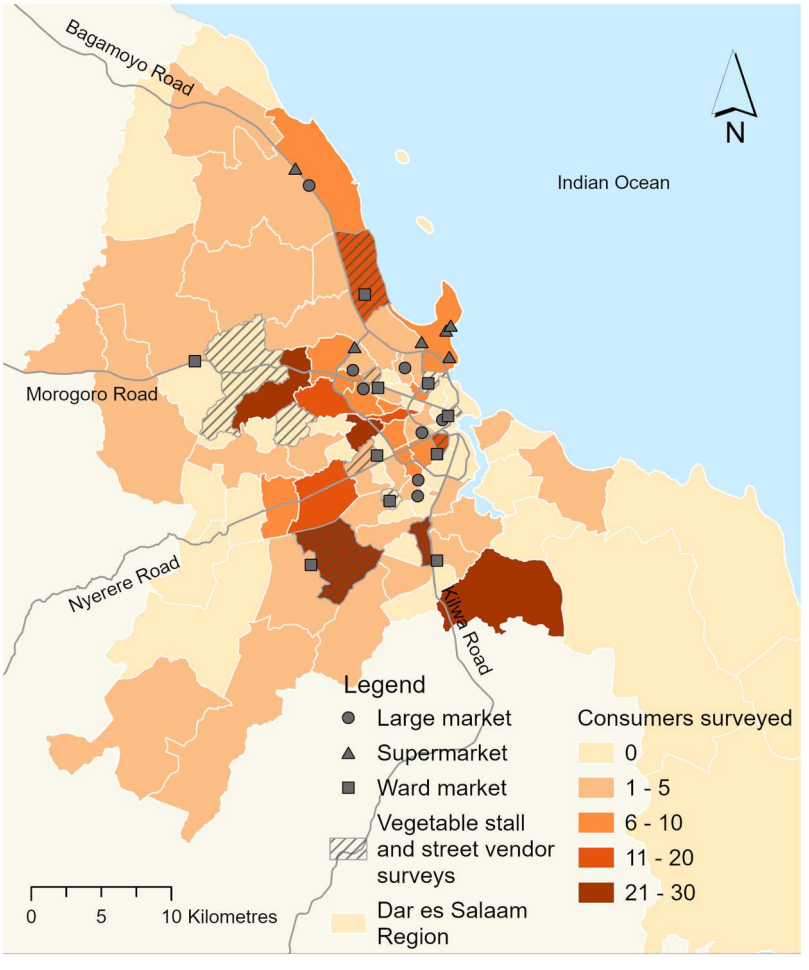

Figure 1. Map of Dar es Salaam Region showing the different survey locations and the number of consumers surveyed per ward.

local research assistants) were conducted between September 2021 and April 2022. This was combined with ethnographic research by the first author in six urban agricultural areas between May 2021 and July 2022. Two rounds of surveys focused on the relationship between producers and vendors, while a third round of surveys focused on the relationship between vendors and consumers. Based on eleven stakeholder interviews, a list of vendor types was created that reflects how urban consumers commonly access leafy vegetables: direct farm access (either by purchasing or own cultivation), markets, street vendors, supermarkets, and fruit and vegetable stalls (this category includes the retail shops where fruits and vegetables, as well as other food items, are sold). Following survey testing, two rounds of surveys were conducted with vendors ($n = 365$), considering the intra-annual variability of food flows. The surveys focused on vendors' food retail and provisioning practices, specifically to understand where amaranth is sourced from. For every municipality included, the two largest markets and the known large supermarkets were selected, as well as one market, vegetable stalls, and street vendors within a random selection of one-tenth of the municipal wards.

The third round of surveys ($n = 358$) focused on the consumers' purchasing behaviour, specifically to understand which of the different food vendor types are most commonly used by households to access amaranth. It was hypothesised that food accessibility, such as purchasing power or market infrastructure, varies across the city. To address this, a pattern of rings based on the distance from the city centre was established to encompass intra-urban, urban, and peri-urban areas (see Appendix). Locations were selected purposively along every ring to cover different areas based on the known socio-economic differences. At every location, 20 surveys were conducted with pedestrians during a transect walk. People were asked from what food vendor, why, and how many bunches of amaranth they purchased every week. Besides this, questions were asked about household characteristics to check the quality of the sample against existing household surveys conducted in Dar es Salaam (URT, 2020). Since the respondents were not necessarily living in the direct vicinity of where the survey took place, the data was linked to the respective ward of residence. The survey data is shown in Figure 1 and all survey locations can be found in the Appendix.

2.2. Foodshed analysis

As this study 'goes with the food flow', we traced the consumed amaranth back from its place of consumption, via the food vendors, to its origin location of production. The analysis (carried out in Python version 3.9.7) presents an extension to the consumer foodshed workflow by Hemerijckx et al. (2023) with the difference that the current analysis quantified the foodshed in absolute quantities (by bunches of amaranth) instead of by its equivalent retail value. In addition, our adapted workflow enables vendor-vendor interactions to be traced, i.e. when vendors obtain their supply from wholesale markets. The dataset of households ($n = 358$) and their amaranth consumption was linked to the vendor dataset ($n = 365$) based on the vendor type where each household indicated they obtained their amaranth supply. The workflow is shown in Figure 2 below. Surveyed households that did not consume any amaranth ($n = 12$), households living outside the study area ($n = 6$), and vendors who did not sell any amaranth ($n = 4$) were excluded from the analysis. Households that did not provide a quantity ($n = 67$) but could explain where they sourced their amaranth, were given the average number of bunches consumed by a household of that size. We assume households obtain amaranth from vendors within their ward of residence, and if multiple food vendors or origin locations are found, the amount (in bunches) is divided equally. If no vendors were surveyed in their specific ward of residence (72% in our survey), the household was linked to vendors within their respective municipality. The foodshed is mapped by assigning the consumed bunches of amaranth to the production locations indicated by the vendors. Once production and consumption locations are known, the average distance travelled from farm to fork is mapped separately to display the consumer foodshed extent (comparable to the 'food miles' concept). These distances are calculated as the Euclidean distance between the centroids of the urban ward of consumption and the urban ward or rural region where the amaranth was cultivated. Many amaranth vendors sourced their produce not directly from the farm but rather at other markets (at 'wholesale vendors'). As both wholesale and retail vendors were found at markets, surveyed vendors selling over 50 bunches per day are considered 'wholesale vendors'.

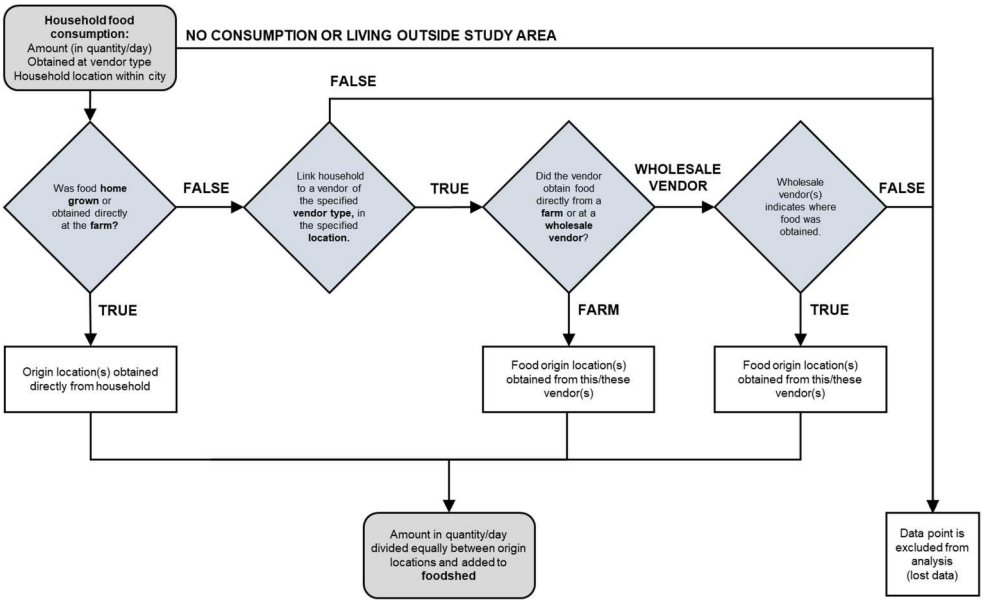

Figure 2. The workflow shows how food consumed by surveyed households is traced back to its origin location. In the context of this paper, the scale of the location is a ward or municipality in Dar es Salaam.

This value was selected as most market vendors offering a wide array of food items for direct sale to consumers – compared to vendors selling leafy vegetables only – sell below this number on an average day.

3. Results and discussion

3.1. The role of consumers and vendors in Dar es Salaam's foodshed

Going with the flow of food within the foodshed gives a comprehensive view of the production locations and the routes taken by the food from farm to fork. For Dar es Salaam, the surveys showed an average household consumption of 4.8 bunches of amaranth per week. As only twelve of the surveyed households did not consume amaranth, this shows how most households regularly consume this leafy vegetable (from daily to several times a week). This is similar to leafy vegetable consumption by urban dwellers in Kenya and Uganda (both about twice a week) (Gido et al., 2017; Hemerijckx et al., 2022). One-tenth of the surveyed consumers directly obtain their amaranth at a farm, either by growing it themselves or by conveniently purchasing leafy vegetables from nearby farmers. The wards where these respondents reside are primarily located in peri-urban areas. This demonstrates that the shortest distances between producer and consumer locations can be found in peri-urban areas where the landscape consists of a mix of urban and agricultural land uses, livelihoods, and lifestyles.

A total of 90% of the surveyed consumers in Dar es Salaam rely on food vendors rather than direct farm access to obtain their leafy vegetables (Table 1(a)). The most important types of food vendors with regard to leafy vegetables are street vendors (36%) and

Table 1. Sources where vendors and consumers obtain their supply of the leafy vegetable amaranth.

Vendor source	Count[a]	Proportion (by number of consumers)	Proportion (by number of bunches)	
a. Vendor types where consumers obtain their supply				
Direct farm purchase (including own production)	33	10%	11%	
Market	79	23%	22%	
Street vendor	123	36%	38%	
Supermarket	1	0.3%	0.2%	
Vegetable stall	104	31%	29%	
No purchase	12	–	–	
Vendor type	**Count[c]**	**Farm**	**Wholesale market**	**Middlemen (no location)**
b. Locations where food vendors obtain their supply[b]				
Retail market	243	39%	60%	1%
Street vendor	14	64%	36%	–
Supermarket[d]	2	25%	–	75%
Vegetable stall	102	24%	75%	1%

[a]$n = 352$; 6 surveys were omitted before analysis since the respondents did not reside in Dar es Salaam.
[b]Vegetable stall, street vendor, and supermarket are not shown since vendors do not obtain their supplies here.
[c]$n = 361$; 4 surveys were omitted before analysis since no amaranth was sold at the respective supermarkets.
[d]The proportion of sourcing locations here is explained by one supermarket indicating the use of two locations.

vegetable stalls (31%). These types of informal vendors that are located close to the consumer are a particularly important economic space for women through which food supply reaches the eater's doorstep. Informal vendors play a prominent role in Africa's urban food security despite facing policy neglect or opposition (Skinner, 2016; Battersby & Watson, 2018a; Wegerif, 2024). Ambikapathi et al. (2021) similarly showed the importance of semi-formal and informal vendors in Dar es Salaam, additionally revealing that 78% of these vendors were women, up to 95% for vendors of leafy vegetables. With the expansion of supermarkets into urban Africa, a decline in the presence and importance of these informal food retailers was expected, but the much talked of supermarket revolution has not materialised in Dar es Salaam and many other African cities (Wegerif, 2017; Nickanor et al., 2021; Hannah et al., 2022). Several supermarkets, including Shoprite and Game, have closed their shops in Dar es Salaam over the last few years. The survey and stakeholder interviews show that supermarkets are generally used by a small proportion of citizens, an elite group, as they are more expensive and less accessible. This corresponds to research by Wanyama et al. (2019) and Hemerijckx et al. (2023) in Kenya and Uganda.

Moving to the vendors' sourcing strategies, they mainly source their amaranth supply directly from farms and by purchasing from wholesale markets (Table 1(b)). More than half of the market vendors (60%) that sell to consumers obtain their amaranth at (other) markets, which shows the difference between wholesale and retail market vendors. It is common to buy leafy vegetables in large bunches (either at markets or from farmers) and split them into smaller bunches later. Other examples of sourcing amaranth are vendors having their own farms, receiving vegetables from farmers elsewhere via telephone orders, or picking up vegetables in the ward of residence before travelling to the location of their vending business. The price per bunch of amaranth sold by vendors (including farmers selling directly to customers) ranges between 200 and 350 TZS (0.09–0.15 USD at the time of research). The prices fluctuate based on scarcity or abundance due to

seasonality, location, and size of a bunch. Interviews found that the size of a bunch sold to consumers can differ over the season in order to deal with price fluctuations. Thus, the size of the bunch rather than its price usually fluctuates when leafy vegetables are scarce or abundant (interview 26 May 2021; 9 November 2021). Vendors with vegetable stalls prefer market locations to source their goods, as they offer a larger variety of food items than what is readily available at urban farms. Street vendors primarily source their leafy vegetables directly from farms (64%). With a variety of leafy vegetables grown on urban farms, they move from door to door to sell at affordable prices.

3.2. Urban agriculture in Dar es Salaam

The surveys show that consumers in Dar es Salaam are connected to agricultural areas for the provision of leafy vegetables in different ways. Urban agriculture in Dar es Salaam can generally be divided into two categories. The first category includes backyard farming (home-based gardening), where people cultivate crops for home consumption within and around their residences. A variety of crops can be found here that cater for household needs. The second category is farming in open spaces within the city. This market-oriented form of agriculture takes place in vacant areas that are either awaiting development or are deemed unsuitable for it. Farmers in these open spaces sell the majority of their produce to vendors and a small portion to residents from the direct vicinity. Amaranth is the most common vegetable for commercial farmers to start with, as it has a high market demand. A farmer commented on the benefits of this crop choice by saying that '*mchicha ni mali*' (which can be translated as amaranth having 'significance' or 'wealth'; interview 4 June 2021). Most farmers interviewed during fieldwork indicate that they derive a reliable income and have more employment stability compared to other (informal) jobs. Urban agriculture is also mentioned as compatible with other kinds of employment and therefore offers an opportunity for risk reduction by diversifying income sources. When farmers can obtain sufficient space, they diversify with other (leafy) vegetables to strengthen their marketing position. This is important since there is a reported increase in leafy vegetables from rural areas. Trucks from areas such as Morogoro (which has a good road connection with Dar es Salaam) travel through the night to supply leafy vegetables to several large markets in the city. Urban farmers therefore put more effort into getting permanent customers and securing buyers in order to lower their dependence on markets.

Urban sprawl puts pressure on the limited space available for farming within the city. Farmers find themselves in a position of uncertainty regarding their (often informal) access to agricultural sites, as they have already been forced to move before, have lost land due to construction in the same location, or have been informed about planned development. A farmer illustrates this tenure insecurity by saying: 'There is no hope for this land. There might be construction in the evening and the next morning your land is not there anymore' (interview 16 June 2021). Wessels & Mgana (2024) give an example of an agricultural area within the built-up areas of Dar es Salaam that transformed into an industrial site. In these processes, it is not only the farmers who must adapt but the entire foodshed as well. Most farmers try to secure land further towards the urban periphery where the pressure on land is less acute. This implies that food supply chains towards consumers become longer, thereby enlarging the foodshed.

Despite the agriculture-to-urban land use transformation, urban agriculture (as a practice) shows persistence to its changing environment, largely without any state or other institutional intervention (Drechsel & Dongus, 2010; Wessels & Mgana, 2024; Wessels et al., 2024).

3.3. Quantifying and mapping the foodshed

Knowing the quantities and directions that amaranth travels enables us to provide quantitative and spatial insight into the foodshed. Figure 3 gives a complete overview from consumer to producer. Starting from the consumer and tracing backwards, we found that 11% of all amaranth is directly sourced from farms within Dar es Salaam. For the remaining part, citizens rely on a combination of different types of vendors of which street vendors (38%) and vegetable stalls (29%) are most prominent for the purchase of amaranth (see also Table 1). As shown in Figure 3, when combining all food flows and disregarding lost data, a total of 70% of the amaranth that is consumed comes from agriculture within Dar es Salaam while 30% per cent is supplied by rural agriculture. The rural-to-urban food provisioning comes from regions in Tanzania that have a relatively good connection with infrastructure to supply food to the city. Examples of regions that are found to be sources of amaranth are Morogoro and Pwani. This supply enters the city primarily through the municipalities' main wholesale markets. Comparing these findings with previous research on green leafy vegetables, the percentage of urban production in other African and Asian cities is found to be 70 per cent and above (Orsini et al., 2013; de Zeeuw & Drechsel, 2015). When compared to the previous study in Dar es Salaam that reported a value of 90 per cent (Stevenson, 1996), we observe a decline in amaranth production in the city which can be attributed to the agricultural-to-urban land use transformation within Dar es Salaam Region that pushed agriculture outside of the city's administrative boundaries. Meanwhile, the total amount of amaranth produced by farmers within Dar es Salaam Region has likely increased given the increased demand due to urban population growth. Urban farmers and the city's

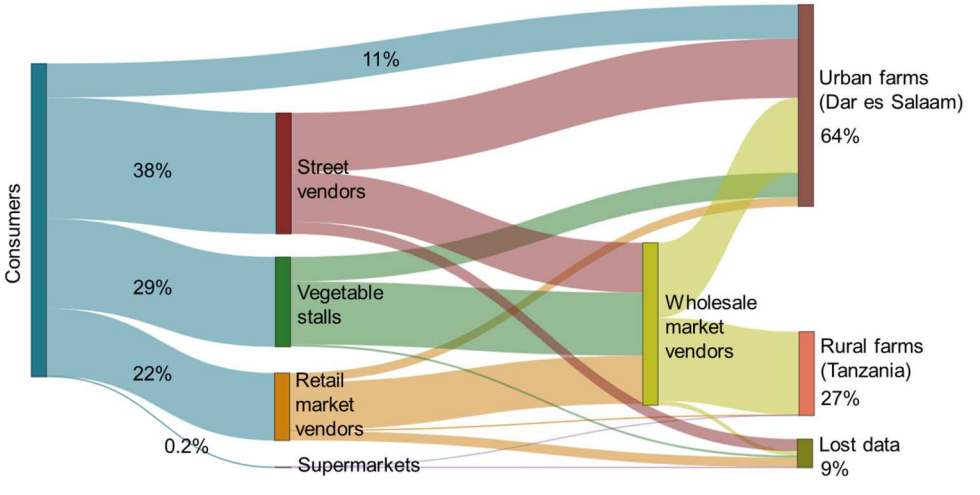

Figure 3. Amaranth flows in Dar es Salaam.

agricultural officers confirm a trend of agricultural practices switching from staple crops to vegetable production in different parts of the city.

Figure 4(a) portrays the areas where amaranth is grown within Dar es Salaam. Most urban farming activity takes place in wards that can be considered peri-urban. Examples are the wards of Kitunda and Kivule which are important production areas often mentioned by vendors as their source location of amaranth (shown as >10% in the figure). Although all wards within the Dar es Salaam Region have been considered urban in this context, the variation is worth mentioning. Where most urban agriculture takes place on the outskirts of the city, there are also agricultural areas within the built-up areas that continue to contribute to the availability of leafy vegetables while being confronted with urban pressures (e.g. water pollution, see Wessels, 2023). Also, one can find (leafy) vegetables being produced just outside the urban administrative region (therefore regarded as rural agriculture here) but showing strong urban characteristics due to their interlinkages with the city. Contrary to the production of other food items, leafy vegetables such as amaranth and other fresh food items (e.g. milk) have remained prominently present in the city region. The agricultural land use patterns in and around the city are configured so that high-value, perishable goods are produced closest to the consumer, while other agricultural commodities are produced further away. This aligns with the Von Thünen model about the relation between markets, production, and distance, which creates different food chain configurations for different food items (Moustier et al., 2023).

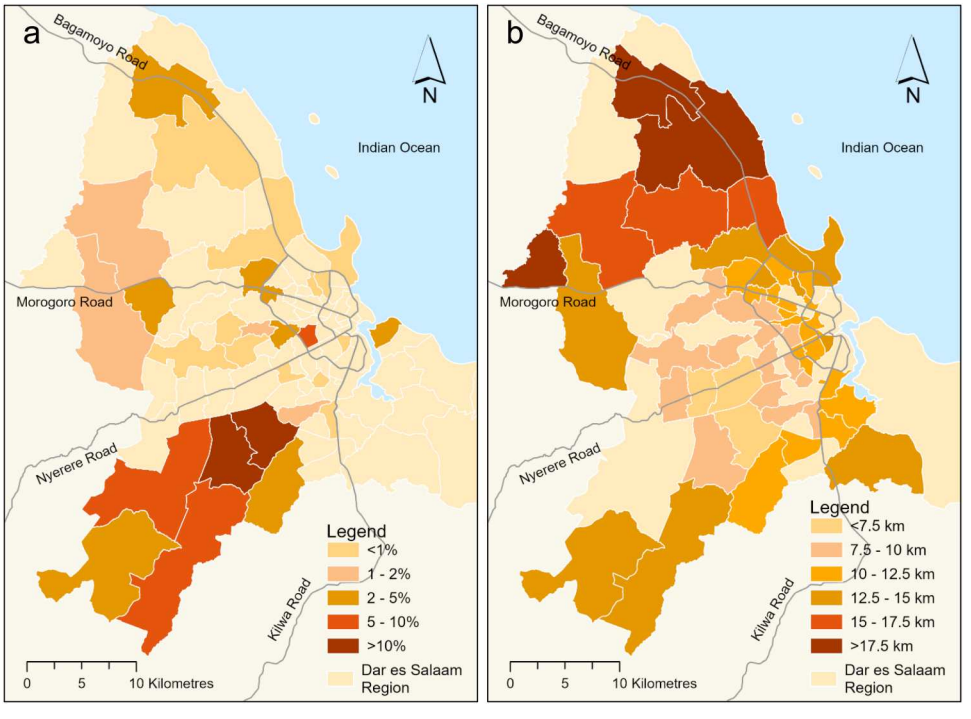

Figure 4. (a) Distribution of production locations of amaranth within Dar es Salaam, as indicated by food vendors; (b) Average distance travelled by amaranth from producer (farm location) to consumption location.

Regarding the length of the amaranth foodshed (shown in Figure 4(b)), the shortest distances (under 7.5 km) are travelled by the amaranth from the origin locations towards household consumers in the area where the highest share of amaranth is produced. Please note that distances are calculated as the Euclidean distance between ward (or for rural sources, the region) centroids, which may explain why being close to larger wards or rural areas may result in larger average foodshed distances. While the study area spans a distance of over 60 km from north to south, the average distance travelled by the consumed amaranth is just 11 km and therefore shows a strongly localised foodshed.

3.4. Limitations

While this study provides an innovative extension to the foodshed approach by Hemerijckx et al. (2023) to visualise food miles and account for vendor-vendor food flows, there are limitations worth discussing. First, our research approach enabled following a vegetable-specific flow in detail, while simultaneously showing the continued role that urban farmers play in the provision of leafy vegetables to the city. The overall contribution of urban agriculture to the city's food requirements should, however, not be overestimated as compared to what is brought to the city from afar. Future research may therefore, with a similar methodological approach of following the food flow, focus on other food items to further understand what part of the food consumed is grown within the same area. While Dar es Salaam is used here as a case example, this methodology can used for comparative research between cities or longitudinal studies in different geographical locales.

Second, we rely on the survey responses to indicate the origin locations and have triangulated this data with stakeholder interviews and ethnographic fieldwork in several agricultural areas throughout the city. The consumer survey, however, only focused on household-level purchases and did not incorporate other categories such as local restaurants (e.g. so-called *mama ntilie*). The question remains how the sources of food items of out-of-home consumption compare to household purchases. An additional sampling limitation is that food vendors and consumers were not always surveyed in the same wards, which led to 72% of the consumer-vendor links being made at the municipality scale instead. This may lead to an overestimation in the foodshed size for wards were consumers, but no vendors, we surveyed. Also, a limitation that requires further research is the low number of street vendors ($n = 14$) surveyed. Their constant mobility within urban neighbourhoods posed challenges in engaging with them. Given the regular engagement of the first author with street vendors while conducting ethnographic fieldwork, the surveys conducted are considered representative of the strongly localised foodshed in which they are embedded. The stakeholder interviews and conversations and observations during urban farm visits also confirm the important role that urban farms play for street vendors but an uncertainty remains regarding the exact figures on where street vendors obtain their supply. Further research on the role of street vendors can enhance this quantitative understanding and illuminate policy support for this predominantly female group.

Third, we used Euclidean distances between production and consumption locations in our analysis and visualisation rather than carrying out road network analyses. This

means that the actual distances travelled from farm to fork by the amaranth might slightly differ from what is presented here. We believe that this approach provides key insights into the configuration of the foodshed while simultaneously adhering to a methodological approach that can be used for other case studies without the need to collect data on road infrastructure. Nonetheless, future research efforts could include other distance measurements (Charreire et al., 2010) to assess the urban foodshed size.

4. Conclusions

In light of rapid urban expansion in Africa, it is imperative to understand the changing configuration and functioning of foodsheds to increase cities' food system resilience. Urban agriculture in Africa is often mentioned as a contributor to urban food availability and accessibility, although quantifications of its actual contribution are scarce and often outdated. This study showed the contribution of urban farmers to the availability and accessibility of leafy vegetables in the city of Dar es Salaam, Tanzania. More than 700 surveys with food vendors and consumers, as well as ethnographic research in urban agricultural areas, enabled us to quantify and map the food flow of the leafy vegetable amaranth. Our study shows that one-tenth of the consumers have direct access to farms in their vicinity while the remaining part of the urban population depends on food vending networks to obtain their leafy vegetables. Two-thirds of all amaranth purchases occur via informal vendors operating in residential neighbourhoods who create the shortest linkages between producer and consumer.

Our analysis shows that the significance of urban and peri-urban agriculture for the availability of leafy vegetables such as amaranth has remained high despite the city's continued growth. Currently, a total of 70 per cent of all amaranth consumed in Dar es Salaam was found to be produced within the city, while a previous study reported a value of 90 per cent (Stevenson, 1996). The decline in total amaranth production in the city can be attributed to the agricultural-to-urban land use transformation within Dar es Salaam Region which has pushed agriculture outside of the city's administrative boundaries. Meanwhile, the total amount of amaranth produced by farmers within Dar es Salaam Region has likely increased given the increased demand due to urban population growth. The boundaries of what is considered 'urban' play an important role in quantitative analyses, although the foodshed has no regard for administrative boundaries. We therefore also showed the localised character of the foodshed by visualising travel distances from producer to consumer. The average distance travelled by amaranth from farm to fork in Dar es Salaam is found to be just 11 km, indicating a strongly localised foodshed for this food type.

Foodshed analyses – such as used in this study – are essential to understand how the flows of food are changing in light of the rapid urban growth in Africa. Foodshed studies enable comparisons over time and between cities to understand how supply chains are changing and where action is required to enhance the resilience and sustainability of the food system. Our method provides an in-depth and innovative approach compared to prior empirical foodshed visualisations for cities in sub-Saharan Africa (e.g. Karg et al., 2016; Hemerijckx et al., 2023). We explicitly map urban food consumers and their respective food sources as spatially diffuse across the city, whereas previously food consumption within the city was considered as a general 'endpoint' of the foodshed. Our

methodology gives insight into the heterogeneous system of providers that create an accessible supply of fresh vegetables to the city but can moreover show where these linkages between producer and consumer are insecure and therefore require action.

This study has several implications for urban planning and policy beyond the case studied. We conclude that there is a continued role for urban areas in providing for their own food demands. As the presence of agriculture in African cities is under pressure, both physically and ideologically, there is a need for urban authorities to actively envision (and strategize) the position of agriculture in the city, and subsequently plan and preserve agricultural land through land use planning or strengthen food flows from rural areas to safeguard the supply of nutritious green leafy vegetables. An analysis of the foodshed can herein inform goal-setting and scenario planning as part of a broader discussion about the benefits of local versus global foodsheds. Besides the food provision mainly focused on in this paper, urban planners should also consider the other ecosystem services that green productive spaces can provide to its citizens. For instance, local production provides economic opportunities for a range of people and the green spaces provided by urban agriculture contribute to the wellbeing of communities by mitigating urban heat islands due to climate change. Incorporating food and the robustness of its supply and accessibility in urban planning ensures that cities can become more liveable, sustainable, and equitable places for all their residents, including those producers and vendors that informally shape the city and its foodshed.

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