The Reality of and Solutions for Food Insecurity in Dar es Salaam

Amelia Critchlow, Zoe Lynch, Sara Gammon, Olivia Byrne and Sean Cobb

CDI Research Paper Series #03/21

This report is part of the Cambridge Development Initiative's (CDI) Student Innovation department research program for the academic year 2020/21. CDI's mission is for students to act as catalysts of impactful, Tanzanian-owned and-led innovations for sustainable development. The Student Innovation department provides research to help support future CDI projects to achieve this.

The CDI Research paper series has brought together students to produce collaborative, peer-reviewed and cross-disciplinary research focused on practical issues affecting vulnerable communities in Dar es Salaam. This series would not have been possible without the efforts of the volunteer student researchers and staff at CDI who have worked tirelessly during their academic year to produce these papers. Additional thanks must also go to the academics and alumni of the University of Cambridge who provided their expertise in the reviewing process, and also to CDI's partners at Kite Dar Es Salaam for their support throughout.

FELICITY GARVEY
Student Innovation and Research Director

This research paper has been produced by the Food Security research working group to support the future development of CDI projects.

The Reality of and Solutions for Food Insecurity in Dar es Salaam
CDI Research Paper Series #03/21
Paper Coordinator and Editor: Felicity Garvey
Team Lead: Sara Gammon
Authors: Amelia Critchlow, Zoe Lynch, Sara Gammon, Olivia Byrne and Sean Cobb
Date of publication: 21 April 2021
Contact: innovation@cambridgedevelopment.org

This publication can be downloaded from www.cambridgedevelopment.org

Cambridge Development Initiative
Registered Charity Number 1159244
CUSU, 17 Mill Lane
Cambridge
CB2 1RX
United Kingdom

Executive Summary

Food security, defined as when "all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996) is of vital importance globally. However, with the rapidity of urbanisation, climate change and the growing demand for a greater variety of foods, ensuring food security for all is increasingly challenging.

The urban population of Tanzania is expected to more than double by 2030 (Wenban-Smith, 2016), and as such cities such as Dar es Salaam will face increasing pressure to provide sufficient food supplies to meet the rising demand. Issues relating to rural-urban food supply linkages, climate and land tenure mean that simply increasing existing production is likely to be insufficient. Based on research into food insecurity in Dar es Salaam, this report discusses the potential for urban and peri-urban agriculture to contribute to ensuring greater food security.

This paper highlights two potential mechanisms through which CDI, in partnership with KITE DSM, might work towards helping combat present and future food insecurity in Dar es Salaam. Firstly, the authors of this paper advise the piloting of simplified hydroponics within the urban and peri-urban sphere to enhance production rates and food availability. This would require initial financial support for implementation as well as a training program. Secondly, the authors advise that education is of great importance in highlighting possibilities for peri-urban household food production. The provision of an educational leaflet to promote greater awareness of the benefits of, and best practice for, urban agriculture is recommended. This would detail information regarding the best crops to grow in different urban spaces to help supplement the diet, as well as advice regarding the possibilities of keeping livestock.

Table of Contents

1. Contextual Overview

To effectively identify opportunities to improve food security in Dar es Salaam, it is first crucial to understand the challenges to the city's food security, including gaps in food availability in terms of quantity of safe and nutritious food and gaps in food access, in terms of economic and physical means to access food (Yaro, 2004; Sassi, 2018). Therefore, this section aims to provide a contextual overview of food security in Tanzania as a whole, before focusing in on Dar es Salaam. This will include the main food sources in the country, overall threats, food availability and access, challenges unique to Dar es Salaam and ongoing developments to alleviate food insecurity.

1.1 Tanzania and Agriculture

Located in East Africa just south of the equator, the United Republic of Tanzania (Figure 1) has a population of 58 million (WFP, 2021), with roughly 35% living in urban areas and 65% in rural areas (WFP, 2020). Despite generally being considered food secure and self-sufficient in crop production (WFP, no date), 5 million people live under the food poverty line, with 2 million of these being in urban areas (WFP, 2020). As such, the chronic malnutrition rate amongst children aged 6-59 months is still as high as 31.8%, and 21% of households in the country are considered to have an "unacceptable" food consumption score - against an average of 34% across the African continent (Alphonce, 2017).

***Figure 1**: Map of Tanzania (taken from: https://www.britannica.com/place/Tanzania)*

1.1.1 Local Agriculture

Local agriculture is central to Tanzania's food security and economy, with local production meeting about 95% of the country's food requirements on average (Ministry of Agriculture Food Security and Cooperatives, 2006). Moreover, it represents 30% of GDP and employs 68% of the total workforce (FAO, 2018). Important to note is the fact that 83% of all holdings are run by small family farmers who dominate the agricultural sector by contributing around 75% of the total agricultural output (ibid). Rural production is characterized by the limited use of modern farming techniques – only 1.4% of smallholder households use motorized equipment, and on average only 1.9% of a smallholders' farmland is irrigated (ibid). Food production is centred around key crops including maize and rice which are dominant, alongside cassava, rice, sweet and Irish potatoes, bananas, sorghum and sugarcane (FAO, 2019).

1.2 Current and Future Challenges

The major factors currently affecting food availability are low production due to the limited productivity of land, labour and other production inputs, high incidences of crop and livestock pests and diseases, inadequate processing, storage and marketing infrastructure (Ministry of Agriculture Food Security and Cooperatives, 2006). In terms of access to food, physical access is affected by inadequate infrastructure, mainly in the transportation network, and economic access is mainly impaired by poverty (ibid). Further challenges are specified and elaborated on below.

1.2.1 Growing Urban Population

Tanzania's urban population is expected to more than double by 2030, with estimates suggesting an increase by 125% by 2030 (this figure rises to as much as 145% for Dar es Salaam) (Wenban-Smith et al., 2016). As a result, not only will total demand for food increase, but the proportion of permanent consumers (people who do not produce food) will increase (Wenban-Smith, 2016). This would leave a larger proportion of the people vulnerable to changes in food availability/accessibility, with urban areas being particularly vulnerable to price fluctuations compared to rural areas (Ministry of Agriculture Food Security and Cooperatives, 2006). At the same time, the rural population is also estimated to increase by around 38%, which would eat into the local marketable surplus to be exported to urban areas (Wenban-Smith et al., 2016). This is a critical issue as urban households mainly obtain food through purchasing (at 97% for Dar es Salaam and 77% for other urban areas), compared to rural households which derive on average 58% from subsistence agriculture (WFP, 2013).

1.2.2 Reliance on Smallholders and Struggles in Smallholder Production

Tanzania's balance of payments remains quite dependent on capital inflows through aid and private investment, leaving little room for imports to cover food requirements (Wenban-Smith, 2016). Hence, future food security is likely to be largely dependent on raising production and productivity in the smallholder rural farming sector.

However, various challenges are faced by smallholders and these pose barriers to raising productivity and transport to urban areas:

- Lack of access to technology: As mentioned earlier, the lacking availability of agricultural technology and techniques has been attributed to low yield per hectare, impairing plans to increase productivity (Alphonce, 2017).
- Poor and costly supply chains: Inadequate physical transport facilities are often reflected in high transaction costs for food processing and marketing, deterring the distribution of food to urban areas by the smallholders (Conforti and Sarris, 2010; Mdoe and Mwagike, 2015).
- Growing competition for resources: Rural food production is increasingly impaired by a growing demand for energy, feed and construction wood. Land pressures due to population growth and land use change might also lead to rural-urban migration, reducing rural manpower to sustain agricultural production (Wenban-Smith et al., 2016).

As a result of the aforementioned low agricultural productivity and high levels of food insecurity in rural areas, the surplus food available to be supplied to urban regions is thus reducing, leading to higher levels of pure subsistence farming (ibid) as a national survey found that only a third of farmers sold some of their crops, and 26% of all farmers did not sell any of their crop production (Morisset et al., 2013). A final factor of importance here is that food prices present a significant dual challenge of ensuring adequate prices for producers to sustain their livelihoods, while also being low enough for consumers to have sufficient access to food (Haug and Hella, 2013).

1.2.3 Climate Change

Given that irrigation is not a particularly common practice, farming in Tanzania is highly dependent on rainfall and therefore has been affected by the severe drought periods over the last decade (FAO, 2018). A model by Arndt et al. (2012) predicted that food security in Tanzania was likely to deteriorate in particular as a consequence of climate change leading to more of these increased periods of drought along with temperature increases and changes in rainfall patterns. All of these will likely serve to reduce crop yields and reliability. Increases in the intensity of rainfall owing to climate change may also increase the frequency and intensity of flooding events, leading to the destruction of not only crops but of economic infrastructure such as transport networks (Arndt et al., 2012), which as noted earlier are crucial for the distribution of food nationally.

1.2.4 Ongoing Developments and Organisations Working in the Country

The threats to rural agricultural production have not gone unnoticed, and the Tanzanian government has launched a policy of Kilimo Kwanza ("Agriculture First" in English) in 2009 (Mkonda, 2016). It aims to foster growth in the agricultural sector and transform it from a subsistence to commercial market through increasing crop production, improving livestock husbandry and undertaking fish farming (Wenban-Smith, 2016). For instance, a project launched under the policy is the Southern Agricultural Growth Corridor of

Tanzania (SAGCOT) Investment Project, which aims to "increase the adoption of new technologies and marketing practices by smallholder farmers through expanding and creating partnerships between smallholder farmers and agribusinesses in the Southern Corridor of Tanzania" (The World Bank, no date).

Other national initiatives have included the Agricultural Sector Development Programs (the (ASDP I & II which ran from 2006-2012 and 2013-2020 respectively), which aim to increase productivity, profitability, and farm incomes (Alphonce, 2017). This would be achieved through increasing farmers' agricultural knowledge, technology, marketing systems, and infrastructure and promoting greater private sector investment through improved regulation (ibid).

1.3 A Focus on Food Security in Dar es Salaam

Dar es Salaam is East Africa's largest city, with an estimated population of 6.7 million as of 2020 (Hoff, 2020), having risen rapidly from 4.4 million in 2012 (Erman et al., 2019). Approximately 80% of Dar es Salaam's population live in unplanned settlements, and an important consequence of this has been the spatial expansion of the city into peri-urban areas (Mlozi et al., 2014).

1.3.1 Food Sources and Availability in Dar es Salaam

As noted earlier, 97% of Dar es Salaam's population purchase food for consumption (Wenban-Smith et al., 2016), and around 7% of total food requirements is derived from locally grown urban agriculture, though this varies by crop (Schmidt, 2012). For instance, urban peri-agriculture (UPA) is estimated to provide 90% of the city's leafy vegetables and 60% of its milk (Jacobi et al., 2000).

Aside from being a food source, urban and prei-urban agriculture holds economic importance as a source of employment – the number of families engaged in agricultural production within the city area has increased from 18% to 67% between 1967-1991, making it the second largest employer after petty trade (Schmidt, 2012). Across the city's three districts, there are an estimated 7,700 farmers in Temeke municipality, 12,000 in Ilala and 15,000 in Kinondoni (Hoogland, 2003). The growth in urban agriculture has been attributed to structural adjustment policies and rapid urbanisation without sufficient economic growth (Schmidt, 2012). For high-income households, UPA has been a response to the business opportunity offered particularly in poultry/egg production. For low- and some middle-income households, UPA is a significant livelihood strategy (Mlozi et al., 2014).

Other developments in terms of food security in the city has been the introduction of supermarkets to increase access to food – by 2004, there were 11 supermarkets in Dar es Salaam, including two domestic supermarkets (Kinabo, 2004). However, their contributions to food security is largely confined to relatively affluent consumers, which

constitute a minority in the city (Wegerif, 2017). Instead, it is a combination of small producers, transporters and traders in an informal network that links rural food production to the growing urban markets (Wenban-Smith et al., 2016).

1.3.2 Challenges To Urban Agriculture in Dar es Salaam

In addition to the general challenges to food security for the country as a whole, and the greater threat of price fluctuations in urban areas, the urban agriculture sector in Dar es Salaam faces additional problems. Firstly, there is a general lack of awareness of the role urban agriculture plays in the dietary, economic and social life of urban residents. As a result, it is generally marginalised by government officials and city planners in favour of boosting rural production (Schmidt, 2012). This has led to a lack of funding for urban farmers, despite the role of urban agriculture in local livelihoods, and this has additionally led to ambiguous laws and unclear enforcement of such laws (ibid).

Secondly, rapid urbanisation has led to growing competition for space, which is expected to reduce the land available for agriculture (Wenban-Smith et al., 2016). Work by Dreschel and Dongus (2010) documenting the changing spatial patterns of urban agriculture in Dar es Salaam has shown that urban agriculture has increasingly been forced onto marginalised lands and hazardous areas. Taking place in spaces without secure land rights, the perception of urban agriculture as a marginal or transitional activity is therefore reinforced – perpetuating stereotypes.

Thirdly, urban agriculture raises public health concerns, as irrigation is often intermittent and waters sources are often dependent on polluted sources (Schmidt, 2012). In particular, the Msimbazi River, which many urban farmers depend on, has levels of lead, cadmium, copper and chromium that exceed World Health Organization standards (Leonard, Mwegoha and Kihampa, 2012). The consumption of food produced using polluted sources include damage to the heart, kidneys, liver and nervous system.

Finally, as with Tanzania as a whole, climate change is expected to impair urban agriculture in Dar es Salaam. The city has seen a strong warming trend over the past four decades and mean annual rainfall has decreased slightly over the past five decades (Mlozi et al., 2014). Projections indicate that warming is only expected to intensify, and the long rainy season (March–May) could become drier overall while the short rainy season (October–December) could become slightly wetter overall (ibid). Already, farmers have experienced climate-related impacts, including decreased milk production and decreased egg laying by hens, increases in livestock pests and diseases, and difficulties in accessing water during drought periods (ibid).

As demonstrated thus far, urban agriculture plays a significant role in Dar es Salaam's food supply yet remains relatively under-researched and supported (Wegerif, 2017). In light of the pressing challenges from urbanisation, climate change and public health issues, this paper draws on areas for improvement suggested by the existing literature,

which strongly emphasizes the need for greater information sharing to improve agricultural practices and facilitate communication between farmers and authorities (Tanzania Food Security and Nutrition Analysis System, 2017; Mlozi et al., 2014; Wenban-Smith et al., 2016). Hence, this paper will focus on solutions to foster awareness and better technical practices. Two main recommendations are put forth: (i) Adoption of hydroponics, (ii) Education and information dissemination on urban and peri-urban agriculture.

2. Practical Recommendations for CDI

2.1 Hydroponics

One urban agricultural practice which we see as having great potential to be effective at reducing food insecurity in Dar es Salaam is the use and promotion of hydroponics. This is a simple and low-cost method which enables individuals to grow vegetables in the absence of soil (FAO, 2001), therefore making it highly relevant to the growing urbanisation in Dar es Salaam. We suggest that our recommendations would be most effectively aimed at the household level, as simplified hydroponics has been shown to be an invaluable and sustainable method promoting food security at this scale.

2.1.1 Benefits of hydroponics and their relevance to Dar es Salaam

The benefits of hydroponics are many. Firstly, it is highly resource-efficient, which is particularly valuable in the wider context of Dar es Salaam. In terms of cost, Bradley and Marulanda (2001) estimate that, for only $30 worth of nutrients, hydroponics can provide about $300 worth of food. Additionally, once established, the recycling of nutrients means that these systems are self-sustaining and there is little waste, enhancing the cost efficiency in the long term too. This practice is particularly effective at improving household food security as it will, when managed correctly, produce food four times faster than traditional methods, providing enough produce for an average-size family each day (Bradley and Marulanda, 2001). Therefore, simplified hydroponics may address family food requirements, whilst also holding potential for small income generation (Fecondini et al., 2010). Similarly, this efficiency extends to water usage. Hydroponics entails a closed system; therefore, it does not experience the same rates of evaporation as traditional agricultural practices (Vertical Roots, 2020), using 80% less water in total (Borgen Project, 2018). This is particularly valuable in the context of the relative water insecurity and the irregularity of supply in Dar es Salaam (Dongus, 2000). Furthermore, the infertility of the soils in Dar es Salaam (ibid.) means that the absence of soil in this process enhances its applicability and relevance.

Additionally, hydroponics share the many benefits of regular urban and peri-urban agriculture, whilst also maximising space efficiency in the context of a rapidly growing urban centre. In hydroponics, plants can be grown in close proximity as well as making use of vertical space, therefore conserving the area used and increasing the scale and variety of yields (FAO, 2001). When growing the species deemed to be effectively grown under hydroponics, a single household can produce a very high yield potential and, according to the Food and Agriculture Organisation (2001), can provide up to 50kg of fresh produce per m2 per year. According to both Dongus (2000) and the Netherlands Enterprise Agency (2015), land ownership is a complicated issue in Tanzania as a whole, and land use is relatively insecure. Therefore, this practice promotes the empowerment of individuals to be able to grow their own produce in their own homes and gardens with minimal space requirement. By locating production close to the consumer base, we may

also reduce post-harvest losses, which have been identified as another key cause of food insecurity in Dar es Salaam (FAO, 2001)

Furthermore, the lack of appropriate food storage has not only been noted to be a key cause of food insecurity in Dar es Salaam, but also impacts on the types and varieties of food which individuals can, and do, buy (Wegerif, 2017). According to Dongus (2000), more than 90% of leafy vegetables in Dar es Salaam come from either open space agriculture in the city itself, or from home gardens (Dongus, 2000). Therefore, through promoting household use of hydroponics, we may enhance the variety of produce which households are able to consume. Similarly, in hydroponics, the food is harvested immediately prior to being consumed, therefore its vitamin values are retained (Bradley and Marulanda, 2001).

2.1.2 Recommendations for Action by CDI

Recommendation 1: Simplified hydroponics for implementation by households

Firstly, we suggest the promotion and implementation of simplified hydroponics which, with training (see recommendation 2) and a small initial investment (Borgen Project, 2018), would enable households to independently grow high yield crops sustainably. In Bradley and Marulanda's article in 2001, 'Simplified Hydroponics to Reduce Global Hunger', the authors detail the creation of the two types of bed growers that are involved in simplified hydroponics and the equipment necessary for each. Firstly, the flood-and-drain system, which is watered once a day with nutrient-infused water, can be used to produce a variety of different vegetables including tomatoes, bell peppers and herbs (Bradley and Marulanda, 2001). This model requires a drain hole at least 1.5cm above the bottom surface, encouraging a thin water table at the bottom of the media (Ibid.). Roughly every 1m2 will require 2 litres of water each day, with any runoff water collected in a bucket and reused the next day (Ibid.). The second model is the floating bed grower. This grower entails a bed which remains filled with nutrient-rich water and has a white Styrofoam board with holes to support the growth of lettuce plants floating in the water (Ibid.). This grower is aerated by hand twice a day to promote a healthy root environment (Ibid). In total, the tools needed to create these growers are a substrate, wooden pallets, a plastic sheet, seeds, water and a nutrient solution (FAO, 2001). They may be built by hand in just a few hours (Bradley and Marulanda, 2001). Additionally, natural substrates such as sand or pumice can be used which can ensure lower costs (Becraft, 2017).

In terms of the scale of the initial investment, according to a project by Terrascope (2014) which discussed the implementation of simplified hydroponics in Tropical Asia, the cost of setting up a garden, alongside a year's supply of nutrients and seeds would amount to $355. However, this figure should only be taken as a rough estimate, as the market value of the seeds and nutrients will be specific to Dar es Salaam, and CDI may wish to selectively fund certain aspects of these gardens. Similarly, the types of produce to be grown should be selected according to financial feasibility, market availability, as well as

households' demands. By engaging more directly with households and their demands, we hope that the long-term maintenance of these systems would be encouraged.

Recommendation 2: Training programme

Secondly, we suggest that CDI implement small training programmes across a set of accessible locations in Dar es Salaam, within which the necessary equipment is made available alongside instructions for how to perform hydroponics successfully and efficiently. Past research has found that hydroponics can be successfully taught in education programmes as the techniques are easy to understand and require no prior knowledge of methods in hydroponics (Caldeyro-Stajano, 2004 cited in Becraft, 2017). As an initial focus, CDI could engage with local schools to encourage interest in hydroponic farming amongst young people, whilst also enhancing accessibility for the wider community. As mentioned previously, these training programmes should actively engage with community interests, particularly in terms of the types of crops which households would most like to grow.

We also suggest that the promotion of hydroponics may be used to promote gender equality (Wegerif, 2017). Home gardening is most commonly practised by women in Dar es Salaam (Dongus, 2000). However, in Dongus's (2000) analysis of the Urban Vegetable Promotion Project in Dar es Salaam, which aims to support urban farmers in improving vegetable production through upgrading community extension services, strengthening urban farmers' organisation capacity and providing information on urban agriculture, the project was noted to have risked neglecting to acknowledge the importance of women. As a result, we suggest that our training programmes should respond to this call and be focused on promoting gender inclusion, recognising that the distance to sites of training, lack of transportation and childcare facilities, and male trainer bias have all been noted to reduce female participation in these services (FAO, 2001). Whilst the Urban Vegetable Promotion Project focused on urban farmers, our focus on households has a significant vested interest in female inclusion. According to the Food and Agriculture Organisation (2001), women's income has a greater positive impact on the health and nutritional status of children than men's income, therefore demonstrating the encouraging potential that female financial successes in particular may have for enhancing household food security. In essence, the promotion and support for households to use hydroponics is not only a cost and resource efficient means to enhance food security, but also holds a great potential to promote a social benefit too.

2.1.3 Limitations

Limitations to hydroponics as an implementable solution by CDI to enhance food security include that the process requires some initial financial investment and training. Hydroponics/soil-less cultivation does require a relatively high initial cost and technical knowledge to produce crops on a large scale and maintain optimum production yields (Resh, 2013; Pandey et al., 2009). However, the systems we recommend for Dar es Salaam are likely to be on a more manageable, smaller scale which may result in lower costs.

Knowledge of how to operate the hydroponic control systems is needed, which requires access to training and advice (Wootton-Beard, 2019). It may be possible to receive such advice from a KITE-led program or a local farming organisation. Inaccuracy or imprecisions within the traditional soil-based production system is relatively forgiving, but imprecisions in hydroponics can generate heavy losses of crops and further expenses (Wootton-Beard, 2019). Also, since all of the crops share the same nutrients in a hydroponics system, water borne diseases can spread between crops rapidly (Ikeda et al, 2002). Water borne pathogens such as *Phytophthora app.* present a biosecurity risk, especially in recirculating systems which can allow pathogens to build up over a period of time, so it is important that irrigation water is regularly tested and treated and that sanitation measures are carefully implemented and controlled (Wootton-Beard, 2019). If crops are covered, pest infestation can occur if effective integrated pest management (IPM) strategies are not actively pursued (Wootton-Beard, 2019). It is also important that EC, pH and the correct nutrient solution concentration is applied, and a reliable energy supply and light is needed to run the system (Sharma et al., 2009). Moreover, it is worth noting that limited oxygen levels and hot weather can result in crop losses (Sharma et al., 2009). Hydroponic plants react more rapidly than soil-based crops to changes in the environment, showing deficiencies quickly if the environment changes for the worst (Pandey et al., 2009).

Whilst implementing hydroponics requires an initial upfront cost and a certain level of training, as well as ongoing monitoring, it is the belief of the authors of this paper that such a system could be genuinely beneficial and effective. While it would take some time for CDI to be able to develop a pilot for this, a program to offer training and equipment – perhaps in collaboration with other NGOs operating in Dar es Salaam - could enhance food security efficiently with little available land and where soil resources are depleted, sustainably intensifying the production of crops (Wootton-Beard, 2019).

2.2 Education on Peri-Urban Agriculture

A second aspect of addressing food insecurity in Dar Es Salaam which could be adopted into CDI policy is the need for better promotion, education and awareness of best practices in urban agriculture. We emphasise the need for collaboration and better communication between agriculture groups in the city. This is something CDI can work to facilitate and assist through the production and dissemination of leaflets. This could make urban agriculture a more accessible prospect for many, emphasising low-budget solutions and nutritious options for people who had not considered it or lack the time or income to get involved. It could also help to support those who do already engage with peri-urban and urban agriculture in obtaining better yields. An effective project should draw on the existing networks and farming cooperatives which already exist in Dar Es Salaam, and in collaboration with KITE, make their knowledge of urban agriculture available to more people.

2.2.1 Benefits of Education on Peri-Urban Agriculture

Urban agriculture has often been overlooked in policy by state planning departments due to negative stereotypes surrounding its informality. In spite of this, evidence has shown that there is an increasing recognition of peri-urban and urban household-level agriculture's ability to feed a growing urban population, process waste and contribute to food security (Brinkley, 2012). There are a number of farming cooperatives in Dar Es Salaam which contribute to food security in the local communities. These tend to operate largely without formal recognition or support from local government, however, and seem to be spatially fragmented in their reach across the city and have varying access to resources and secure land tenure (Schmidt et al, 2015). Furthermore, studies have emphasised the unpredictability of land tenure arrangements and access to plots for urban agriculture (Mougeout, 2015a). Creating a comprehensive leaflet to share information about good locations for agriculture, and knowledge of cultivation techniques, would make the process of urban and peri-urban agriculture easier for people to adopt, and help to facilitate access to land who might lack the social networks required. While institutional support from planning departments is important, this policy recommendation emphasises Halloran and Magid's (2013) focus on grassroots level, bottom-up solutions and engagement with multiple stakeholders.

The importance of education has been evidenced by many similar studies. Makizu (2019) for example, argues in relation to post-harvest storage that education could play a role in giving farmers the confidence and practical experience to incorporate new technologies into storage and transportation. This is reinforced by Ngowi et al (2019) who recommend the adoption of education, training, seminars and extension visits to help farmers improve crop handling and storage. Further studies emphasise the importance of raising awareness in the broader community about urban agriculture to promote it as a practical way to access nutritious foods, bringing in actors such as the media and planning departments to create networks which ensure more equal access to resources and information.

Schmidt (2011) for example, argues that there is a "general lack of awareness of the role urban agriculture plays in the dietary, economic, and social life of urban residents and consequent marginalization of agriculture by government officials and city planners" (Schmidt, 2011: 3). This echoes Sawio's (1998) calls for the involvement of the mass media, such as the publication of leaflets, in discussing urban agriculture as a viable option to make knowledge about agricultural practices such as irrigation, harvesting and pest control more widely available, and the establishment of community networks to aid the sharing of these resources. While urban agriculture is still somewhat 'looked down upon' and sees limited recognition, the authors of this paper believe that increased prominence could open it up as a viable option for many who have not previously considered it. This will be achievable particularly through greater access to resources and information making it easier for people to explore low budget options to get started. As urban agriculture is currently dependent on access to land which can be determined by

social networks and membership of groups such as farmers cooperatives which can claim the use of land, newcomers to the city may find it hard to get involved in it (Mougeout, 2015a). Therefore, any attempt to make the practice more predictable and accessible could greatly improve food security.

The leaflet in question would include information about the nutritional benefits of individual crops as well as how to grow them, and information about storage, the suitability of pesticides and fertiliser use. It is important for these resources to be adaptable so that guidance on best practice can change based on the experiences of different communities by way of a forum where advice can be shared. Guidance could take the form of Mougeout's four strategies for improving urban agriculture: intensifying yields, specialising in certain systems or crops, using off-ground systems such as pots and finally utilising above-ground systems such as trellising and shelves (2015a).

Furthermore, Wagner and Tasciotti's (2017) study of dietary diversity in Tanzania which surveyed household diets concluded that households were most heavily reliant on staple foods such as rice but deficient in dairy such as milk and eggs and fruit and vegetables. This has significant implications for the health of children, potentially leading to malnourishment. Urban agriculture has the potential to contribute to improving dietary diversity, especially the production of meat and eggs and non-staple foods to ensure people have access to a balanced diet (Wagner and Tasciotti, 2015). Therefore, educational resources should focus on growing vegetables and keeping livestock in space-efficient ways to increase awareness about the importance of dietary diversity to health and emphasising workable household solutions. The leaflet could be distributed through community networks, schools, universities or through farmer cooperatives. There could be the potential for state involvement in distributing resources or providing financial or legal assistance for farmers to buy land or resources (Schmidt, 2012).

2.2.2 Recommendations for Action by CDI

Recommendation 1: Educational leaflet on Peri-Urban Agriculture

The publication of an educational leaflet on peri-urban agricultural practices and how to grow certain crops would help to make the practice of peri-urban agriculture more accessible and predictable. A leaflet which highlights how urban agriculture can meet urban consumer's daily food demands in a sustainable way would help to raise awareness of the benefits of this practice. The leaflet should include details of how to employ intensive methods of production, recycling urban waste and natural resources and producing a diverse range of crops as well as livestock (FAO, 2001). The nature of peri-urban agriculture means that production is located in close proximity to consumption centres which reduces post-harvest losses and waste (Ibid.). This practice would also reduce the transport costs and emissions associated with the transport of crops, especially high volume, low-value crops such as cauliflower and cabbage (Western Cape Government Department of Agriculture, 2021)

Recommendations for three broad distinguished groups of farming types in urban and peri-urban areas of Dar es Salaam could be suggested in the leaflet, taking into account the limitations of water resources in each case. For example, families in Dar es Salaam with no access to land may benefit most from creating urban micro-gardens which grow crops floating on water or on substrates. Mushrooms, aromatics and condiments could be produced for sale, since they only require a small amount of space (1 - 10 square metres which receive at least six hours of sunlight daily), as well as vegetable seedlings, ornamental flowers and pot plants and fruit tree saplings (FAO, 2001). Women and children or members of the unemployed labour force are the most significant actors in micro-gardens in urban areas, and by using simple tools such as wooden pallets, seeds, irrigation water and nutrient solution, this method could contribute to the availability of fresh vegetables for daily consumption, as well as local neighbourhood marketing, increasing food security and potentially providing an additional income source for these economically vulnerable groups (FAO, 2001). Low cost and simple technologies, such as hydroponics, for growing vegetables without soil on patios, terraces and rooftops could also be applied (Ibid.), potentially in partnership with the government or local non-governmental organizations to help with the supply of these technologies. Rice, peat, sand, gravel or peanut husks could, where available, be used as cultivation substrates (Ibid.). This method of farming would use water very efficiently, however, access to mineral fertilisers may be a limiting factor to employing this technique (FAO, 2001). The most suitable crops to grow in this scenario include celery, cabbage, spinach, squash, lettuce, tomato, onion, potato, pepper, strawberries, beetroot, aubergine and beans (Ibid.)

For families with access to small plots in urban areas, small-scale nurseries with intensive cultivation systems using local irrigation methods would be best. Mushrooms, microgreens, herbs such as parsley, basil and chives, berries, fruit trees (such as peaches, plums, pears, apples, oranges, and lemons) and vegetables such as pumpkins, spinach and cabbage as well as potatoes and chickpeas can be grown in this case (McManus, 2021). Water sources for irrigation may be sourced from collected rainwater, protected wells, groundwater or from the municipal water supply network (FAO, 2001). To prevent downstream water sources from being contaminated and to reduce competition between water users small scale localised irrigation methods should be promoted where possible (Ibid.)

For families which are integrated into organised growers, schemes in more open peri-urban and urban spaces could organise small-scale allotments collectively (FAO, 2001.). This would help to develop commercial horticulture to produce high quality vegetables and intensive fruit tree orchards aimed to sell at the market year-round, but also for local consumption (Dongus, 2000). Horticulture species have a high yield potential and thus would be beneficial to grow in Dar es Salaam (Ibid.). Leafy vegetables such as cassava leaves, sweet potato leaves, pumpkin leaves and Mchicha, which have high demand, are also recommended for growing in urban areas, especially since they are perishable and

thus cannot be transported over long distances (Dongus, 2000). Growing fruit and vegetable varieties that are adapted to local climatic conditions is favourable to produce the highest yields, and techniques such as the adoption of Integrated Plant Production and Protection Management (IPP) to avoid excessive fertiliser and pesticide use, as well as cropping system management could be outlined in the leaflet (Ibid.). Diversifying the range of crops grown in more open urban areas, as well as introducing new ornamental crops and livestock products could help to target specific market niches and thus provide a higher level of income for farmers in this scenario (FAO, 2001). Livestock such as cows, chickens and pigs could be kept in open urban areas in Dar es Salaam which would help to reduce the deficiency of dairy such as milk and eggs in household diets in Dar es Salaam (Wagner and Tasciotti, 2017).

In each scenario, utilising the space that farmers have access to can increase household food security and contribute to the household income if excess crops can be sold, as well as increase the nutritional content of diets, as a higher intake of fruit and vegetables can improve iron, Vitamin A and Vitamin C intake (FAO, 2001). According to the farmer's access to space, the leaflet would indicate the supplies needed, which can be purchased from farm input supplies shops in Dar es Salaam (Dongus, 2000), information on the best practices to cultivate crops in that space, as well as the crops best suited to cultivate in each scenario, similar to the Food and Agriculture Association leaflet shown in Figure 2.

***Figure 2**: Plant production and Protection Division, (FAO, 2001).*

The leaflet should also include general recommendations for urban and peri-urban farmers. These would include: using manure and organic waste for composting and to increase soil fertility; improve water use efficiency with precise irrigation scheduling and careful monitoring; maintain and repair boreholes and other irrigation systems to preserve water and prevent leakages; carry out Integrated Pest Management to reduce the risk of infestation, weeds and diseases; establish and maintain effective systems for drainage to prevent flooding and protect infrastructure; maintain a permanent organic soil cover of mulch or cover crops to reduce soil water losses (Western Cape Government Department of Agriculture, 2021). Practices to prevent water loss and wastage are particularly important, given that Dar es Salaam, and Tanzania as a whole, is prone to droughts during some periods of the year.

Recommendations for keeping livestock, which can supply meat, milk and eggs to households, could include: identify and use breeds that are resilient to diseases, parasites, heat and drought; optimising nutrition and animal feed to reduce animal stress; reuse waste water wherever possible to reduce the risk of contamination; avoid positioning pig houses in damp or flood prone areas; have a clear risk management strategy in the event of a disease outbreak and follow proactive animal health management approaches and the advice of veterinarians; provide extra shade to animals kept outdoors; if animals are kept in housing, ensure that environmental control systems function reliably, even when heat waves occur (Western Cape Government Department of Agriculture, 2021). 'Urban' cows are already kept as livestock in Dar es Salaam, and chickens, pigs and goats can also be kept in urban conditions to meet household needs and supplement household income (FAO, 2001).

Information for the leaflet could be drawn from the FAO, as well as in partnership with local farmers groups and cooperatives and relevant Tanzanian Government departments. Primary research and in-depth interviews could also be conducted in Dar es Salaam with relevant stakeholders during the production of the leaflet. The leaflet would also recommend farmers associations that farmers in Dar es Salaam could join for more information and support, and to help implement the above recommendations, and would encourage the diversification of farming activities where possible (Ibid.). This could be facilitated by having access to a directory of local farmers organisations already established in Dar es Salaam and their contact details, and also any government-endorsed schemes and NGOs which promote urban agriculture and facilitate agricultural training schemes.

Should such a project be successful, it could potentially be expanded further, with governmental support. The Tanzanian government's media and planning departments could further promote and raise awareness of peri-urban agriculture by helping to disseminate the leaflet (Schmidt, 2012). By improving the awareness and marketing of peri-urban agriculture products in Dar es Salaam, current concerns about the quality of crops produced in this way would be eased, and farmers would be able to sell their crops

more easily and on a larger scale to businesses such as hotels (Ibid.). The Tanzanian Government could also support the formation of farmers groups and cooperatives based around common needs such as training on pesticide application, irrigation, food processing and storage, and legal assistance, going forward (Ibid.), allowing individuals to maximise the output from their land and access shared tools, knowledge and resources (Schmidt et al., 2015). A more holistic education-based approach going forward could use the information from the leaflet to run workshops in schools which teach children about nutrition and the vitamins and minerals provided by different crops, or as Sawio proposes, even promote the creation of urban young farmers groups (1998).

2.2.3 Limitations

Our proposed solution to produce a leaflet to raise awareness about the practicalities and benefits of carrying out peri-urban agriculture in Dar es Salaam, to facilitate more widespread peri-urban agriculture in the city, is met with political and legal challenges. If people lack the appropriate relationships or social networks required to access land for peri-urban agriculture, it is very difficult to gain land tenure and avoid being evicted from said land at short notice (Mougeout, 2015b). In order to make land tenure more predictable, and to facilitate the practice of peri-urban agriculture more easily, legal changes may be needed to make the application process more transparent, and to allow people to make informed choices about where they plan to grow crops in the city, and what they want to grow (Ibid.).

Since there is current little recognition of peri-urban agriculture in sub-Saharan African cities (Cofie et al., 2003), more support from the government or local authorities for peri-urban agriculture would be recommended, as well as a clearer designation from the authorities about which areas can be used as agricultural land versus residential areas (Brinkly, 2012). To improve land regulation and the current lack of secure tenure arrangements in Dar es Salaam, institutional reform in the Tanzanian Government's Ministry of Food Security, Ministry of Agriculture and Ministry of Livestock and Fisheries may be needed to promote coordination between these departments, and provide more of an incentive for local people to carry out peri-urban agriculture (Schmidt, 2012). This could be done by providing financial assistance and/or temporary permits to farmers who wish to purchase land (Ibid.) If specific pieces of land are designated for peri-urban agriculture by the government, this would help to control the quality and production of the crops produced on the land, as people would feel secure in their land tenure and would be able to meet all the health and safety standards required to produce crops, without the level of uncertainty and precarity peri-urban farmers currently have to face (Schmidt, 2012). More predictable land tenure arrangements would thus allow farmers to make improved choices about what to cultivate within their plot (Mougeot, 2015b). The government could reserve land for this practice which has good potential for agriculture and grazing (Sawio, 1992). Previous literature has even suggested a new government department may be needed to help regulate peri-urban agriculture in the city, especially if the practice becomes more popular (Schmidt, 2012). It is important that

future land distribution and land tenure policies favour women and less advantaged households, who currently struggle to access land (Bryld, 2003 in Wagner & Tasciotti, 2017). Per Mougeout, in an ideal case, women should be allowed to own land in their own name, without being dependent on a man to reach a tenure agreement (2015b). Such a land management system should also be user friendly (Kombe, 2005). Designing urban areas which ban unauthorised construction and designate significantly sized areas for fruit and vegetable production is necessary to reap the benefits of urban and peri-urban agriculture (FAO, 2001).

There are, therefore, clearly some barriers to such a project. However, it is the view of the authors of this paper that facilitating the practice of peri-urban agriculture in the city can have many benefits for individuals and their livelihoods, accelerating poverty reduction by providing new income sources and employment opportunities for local people which is the primary goal of the United Nations Sustainable Development Goals (Ayambire et al, 2019).

Conclusions

This report concludes that the implementation of simplified hydroponics, with some initial investment, will help contribute to meeting the growing demand for food in Dar es Salaam. Hydroponics increase yields per hectare over conventional methods, use 80% less water (Borgen Project, 2018) and produce less waste. This will help to improve food security in the city as the impacts of climate change are made more visible and droughts in this region become more severe. The recommendation to produce an educational leaflet on peri-urban agriculture seeks to improve awareness about urban agriculture – not just for practitioners, but also for officials and city planners, so that this practice can be brought to attention and promoted in Dar es Salaam to increase the productivity of urban land, employment levels and further information sharing between authorities and farmers (Wenban-Smith et al., 2016). These recommendations will enhance established Tanzanian government policies on agriculture such as the Klimo Kwanza policy (translated as "Agriculture First'' in English) established in 2009, as well as the government's national Agricultural Sector Development Programmes which ran from 2006-2012 and 2013-2020 (Alphonce, 2017) which aim to increase farmers agricultural knowledge and the implementation of new and existing technologies. It is the belief of the authors that facilitating the suggested projects in this paper will benefit individual's food security, and livelihoods by enhancing employment opportunities, helping to promote the United Nations Sustainable Development Goals of accelerating poverty reduction (Goal 1) and promoting sustainable cities and communities (Goal 11).

References

Alphonce, R. (2017) 'ENDING RURAL HUNGER: The case of Tanzania', p. 60.

Arndt, C. et al. (2012) 'Climate Change, Agriculture and Food Security in Tanzania', Review of Development Economics, 16(3), pp. 378–393. doi: https://doi.org/10.1111/j.1467-9361.2012.00669.x.

Ayambire, R.A., Amponsah, O., Peprah, C. and Takyi, S.A. (2019). A review of practices for sustaining urban and peri-urban agriculture: Implications for land use planning in rapidly urbanising Ghanaian cities. *Land Use Policy*, 84, pp.260–277.

Becraft, A. (2017). Potential for home-use hydroponic systems to increase food security in Cape Eleuthera, Bahamas. *i-ACES*, [online] 3(1), pp.12–18. Available at: https://ugresearchjournals.illinois.edu/index.php/iaces/article/view/472 [Accessed 2 Apr. 2021].

Borgen Project (2018). Hydroponic Systems: Food Security in Developing Countries. [online] The Borgen Project. Available at: https://borgenproject.org/simplified-hydroponics-offer-soil-less-food-security/.

Bradley, P. and Marulanda, C. (2001). Simplified Hydroponics to Reduce Global Hunger. Acta Horticulturae, (554), pp.289–296.

Brinkley, C. (2012). Evaluating the Benefits of Peri-Urban Agriculture. Journal of Planning Literature. 27: 3. P259-269.https://doi.org/10.1177/0885412211435172
Bryld, E. 2003. "Potentials, Problems, and Policy Implications for Urban Agriculture in Developing Countries." *Agriculture and Human Values* 20 (1): pp.79–86.

Chegere, Martin & Lokina, Razack & Mwakaje, Agnes. (2020). The impact of improved storage technology and training on food security in Tanzania. 10.13140/RG.2.2.29605.86244.

Cofie, O.O., Veenhuizen, R.V., Drechsel, P., 2003. Contribution of urban and peri-urban agriculture to food security in **sub-Saharan Africa**, Africa session of 3rd WWF, 17th March, 2003, Kyoto. http://www.ruaf.org/sites/default/files/contribution_ua_food_security.pdf. [Accessed January, 2021.]

Conforti, P. and Sarris, A. (2010) 'Liberalizing Trade Under Structural Constraints in Developing Countries: A General Equilibrium Analysis of Tanzania', Food Security in

Africa: Market and Trade Policy for Staple Foods in Eastern and Southern Africa. doi: 10.4337/9781849806367.00010.

Dongus, S. (2000). Dar es Salaam Urban Agriculture. [online] www.cityfarmer.org. Available at: https://www.cityfarmer.org/daressalaam.html [Accessed 4 Mar. 2021].

Drechsel, P. and Dongus, S. (2010) Dynamics and sustainability of urban agriculture: Examples from sub-Saharan Africa. Available at: https://www.researchgate.net/publication/225613981_Dynamics_and_sustainability_of_urban_agriculture_Examples_from_sub-Saharan_Africa.

Fecondini, M., Damasio de Faria, A.C., Michelon, N., Mezzetti, M., Orsini, F. and Gianquinto, G. (2010). Learning the value of gardening: Results from an experience of community based simplified hydroponics in North-East Brazil. *Acta Horticulturae*, (881), pp.111–116.

Erman, A. et al. (2019) 'Wading Out the Storm: The Role of Poverty in Exposure, Vulnerability and Resilience to Floods in Dar Es Salaam'.

Food and Agriculture Organisation. (2001). Urban and Peri-Urban Agriculture. [online] Available at: http://www.fao.org/fileadmin/templates/FCIT/PDF/briefing_guide.pdf [Accessed 4 Mar. 2021].

FAO (2018) 'Country factsheet on small family farms: TANZANIA | FAO'. Food and Agriculture Organization. Available at: http://www.fao.org/family-farming/detail/en/c/1115198/.

FAO (2019) 'The United Republic of Tanzania Resilience Strategy 2019–2022'. Available at: http://www.fao.org/emergencies/resources/documents/resources-detail/en/c/1197192/

Haug, R. and Hella, J. (2013) 'The art of balancing food security: Securing availability and affordability of food in Tanzania', Food Security, 5. doi: 10.1007/s12571-013-0266-8.

Hoff, M. (2020) These are the 15 fastest-growing cities in the world, World Economic Forum. Available at: https://www.weforum.org/agenda/2020/02/15-fastest-growing-cities-world-africa-populations-shift/.

Ikeda, H., Koohakan, P. and Jaenaksorn, T. 2002. Problems and counter measures in there use of the nutrient solution in soilless production. Acta Horticulturae 578: 213-219.

Jacobi, P. et al. (2000) 'Urban agriculture in Dar es Salaam: providing an indispensable part of the diet.'.

Kinabo, J. (2004) 'Impact of globalization on food consumption, health and nutrition in urban areas: a case study of Dar es Salaam, United Republic of Tanzania.', in Globalization of food systems in developing countries: impact on food security and nutrition, p. 116.

Kombe, W.J. (2005). Land use dynamics in peri-urban areas and their implications on the urban growth and form: the case of Dar es Salaam, Tanzania. *Habitat International*, 29(1), pp.113–135.

Leonard, S., Mwegoha, W. and Kihampa, C. (2012) 'Heavy metals pollution and urban agriculture in Msimbazi River valley: Health risks and public awareness', International Journal of Plant, Animal and Environmental Sciences, 2, pp. 107–118.

McManus, Beau. "What Plants Can Be Grown in Aeroponics? 19 Plants You Never Considered." *Small Scale Gardener*, 2021, smallscalegardener.com/what-plants-grow-aeroponics/.

Mdoe, N. and Mwagike, L. (2015) 'The role of middlemen in fresh tomato supply chain in Kilolo district, Tanzania'.

Ministry of Agriculture Food Security and Cooperatives (2006) 'FOLLOW-UP OF THE IMPLEMENTATION OF THE WORLD FOOD SUMMIT PLAN OF ACTION'.

Mkonda, M. (2016) 'Efficacy of Transforming Agriculture for Survival to Commercial Agriculture through "Kilimo Kwanza" Initiative in Tanzania', Natural Resources and Conservation, 4(4): 43-50, 2016. doi: 10.13189/nrc.2016.040401.

Mlozi, M. R. S. et al. (2014) 'Building Urban Resilience: Assessing Urban and Peri-urban Agriculture in Dar es Salaam, Tanzania', p. 52.

Morisset, J., Gaddis, I. and Wane, W. (2013) Why Tanzanian farmers don't sell what they produce?, World Bank Blogs. Available at: https://blogs.worldbank.org/africacan/why-don-t-tanzanian-farmers-sell-what-they-produce

Mougeot, L. (2015a) Urban Agriculture in Cities of the Global South: four logics of integration in Food and the city: Histories of culture and cultivation (Imbert, 2015)

Mougeot, L. (2015b). *What Is Urban Agriculture Today?* [online] . Available at: http://www.cityfarmer.org/LucMougeot2015.pdf [Accessed 17 Mar. 2021].

Netherlands Enterprise Agency (2015). Tanzania Horticulture. [online] . Available at: https://www.rvo.nl/sites/default/files/2017/05/Tanzania%20Tuinbouwsecor%20Overzicht.pdf [Accessed 4 Mar. 2021].

Pandey, R., Jain, V. and Singh, K.P. (2009). *(PDF) Hydroponics Agriculture: Its Status, Scope and Limitations*. [online] ResearchGate. Available at: https://www.researchgate.net/publication/259786326_Hydroponics_Agriculture_Its_Status_Scope_and_Limitations.

Resh, H.M. 2013. Hydroponic Food Production: a Definitive Guidebook for the Advanced Home Gardener and the
Commercial Hydroponic Grower. CRC Press, Boca Raton, FL.

Sassi, M. (2018) Understanding Food Insecurity: Key Features, Indicators, and Response Design. Springer International Publishing. doi: 10.1007/978-3-319-70362-6.

Sawio C.J. (1998) Managing Urban Agriculture in Dar es Salaam. University of Dar es Salaam,Tanzania.https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/23305/108517.pdf?sequence=1

Schmidt, S. (2012) Getting the policy right: Urban Agriculture in Dar Es Salaam, Tanzania. International Development Planning Review. DOI: 10.3828/idpr.2012.9

Schmidt, S, Magigi, W. Godfrey, B. (2015). The organization of urban agriculture: Farmer associations and urbanization in Tanzania. Cities:42b, pp153-159

Sharma, N., Kumar, K., Acharya, S. and Singh, N. (2019). *(PDF) Hydroponics as an advanced technique for vegetable production: An overview*. [online] ResearchGate. Available at: https://www.researchgate.net/publication/330080392_Hydroponics_as_an_advanced_technique_for_vegetable_production_An_overview.

Tanzania | Culture, Religion, Population, Language, & People (no date) Encyclopedia Britannica. Available at: https://www.britannica.com/place/Tanzania.

Tanzania Food Security and Nutrition Analysis System (2017) 'Comprehensive Food Security and Nutrition Assessment Report'.

Terrascope (2014). *Mission 2014: Feeding the World*. [online] 12.000.scripts.mit.edu. Available at: http://12.000.scripts.mit.edu/mission2014/about-terrascope [Accessed 2 Apr. 2021].

The World Bank (no date) World Bank Project: Southern Agricultural Growth Corridor of Tanzania Investment Project - P125728, World Bank. Available at: https://projects.worldbank.org/en/projects-operations/project-detail/P125728.

Vertical Roots (2020). What is hydroponic farming? Why use hydroponics? [online] Vertical Roots. Available at: https://www.verticalroots.com/the-what-and-why-of-hydroponic-farming/.

Wagner, N. and Tasciotti, L. (2017). Urban agriculture, dietary diversity and child health in a sample of Tanzanian town folk. *Canadian Journal of Development Studies / Revue canadienne d'études du développement*, 39(2), pp.234–251.

Wegerif, Marc. (2017). Feeding Dar es Salaam: a symbiotic food system perspective. 10.18174/414390.

Wenban-Smith, H. (2016) Food insecurity in urban Tanzania, IGC. Available at: https://www.theigc.org/blog/food-insecurity-in-urban-tanzania/.

Wenban-Smith, H., Faße, A. and Grote, U. (2016) 'Food security in Tanzania: the challenge of rapid urbanisation', Food Security, 8(5), pp. 973–984. doi: 10.1007/s12571-016-0612-8.

Western Cape Government Department of Agriculture (2021). *CASE STUDY #5*. [online] . Available at: https://www.greenagri.org.za/assets/documents-/SmartAgri/Case-Studies/PERI-URBAN-AGRICULTURE.pdf.

WFP (2013) 'Comprehensive food security and vulnerability analysis Tanzania 2012'.

WFP (2020) 'Food Security Overview Context of COVID-19'.

WFP (2021) 'WFP Tanzania Country Brief FEBRUARY 2021'.

WFP (no date) Tanzania | World Food Programme. Available at: https://www.wfp.org/countries/tanzania.
Wootton-Beard, P. (2019). Growing without soil: An overview of hydroponics. Farming Connect.

Yaro, J. A. (2004) 'Theorizing food insecurity: building a livelihood vulnerability framework for researching food insecurity', Norsk Geografisk Tidsskrift - Norwegian Journal of Geography, 58(1), pp. 23–37. doi: 10.1080/00291950410004375.