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THE USE OF URBAN PLANT RESOURCES FOR HEALTH AND FOOD SECURITY IN KAMPALA, UGANDA

A Thesis for a Double Degree of Doctor of Philosophy

by

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"Gardens are fascinating topics of study in no small way because they truly transcend time, culture environment/nature, gender and thought. Although - perhaps because - they are geographically small, gardens are ideal mirrors of the human condition. They are geographical manifestations of human-environment interactions that have attracted some scholarly attention but nowhere near as much as they deserve."

W.E. Doolittle 2004

Executive Summary

With some of the highest urbanisation rates in the world, Sub-Saharan Africa faces serious challenges in providing sufficient, healthy and affordable foods for its growing urban populations. Urban biodiversity, such as homegardens can provide people with healthy food products in addition to other ecosystem services. However urban plant systems are under threat, and even though they provide multiple uses they are still poorly understood. In this dissertation, I explored two urban landscape options: homegardens and wild collection. The overall aim of this study was to provide an understanding of the current and potential contribution of urban plant resources to human wellbeing (with a focus on food security) in Kampala, Uganda. To fulfil this aim, I created 4 objectives: 1) to assess plant species composition and use in Kampala's homegardens, 2) to explore associations between homegardens and socio-economic determinants of dietary diversity and fruit consumption of children aged 2-5 years, 3) to explore the prevalence and determinants of wild plant collectors in Kampala, Uganda, and 4) to assess the extent and importance of alternative food sources of different food groups for low income people. Through a two-stage cluster sampling design in inner-, outer- and peri-urban parts of the city, 96 low-income households were purposively selected in nine parishes. These homegardens were inventoried, plant uses were documented and respondents interviewed on socio-economic data, the status of household food insecurity and food sources. In addition, respondents were asked about wild collection behaviour. Dietary data (for Dietary Diversity Score (DDS) and Food Variety Score (FVS)) were collected from an index child (aged 2-5 years) and the child's female caretaker. In the final dataset (n=74) a total of 270 plant species were identified of which 248 different food plants were considered useful: 101 medicinal species, 70 food plants, 53 technical plants and 24 ornamental species. Even though this study provided no direct evidence that higher garden agrobiodiversity improves dietary diversity and nutritional status of children during the fieldwork season, comparisons with secondary data suggests that the children included in this study have better nutritional status then urban children in Uganda overall. This could indicate that children with access to homegardens have better nutritional status. Moreover 5% of the food items consumed during the recall was derived from the homegardens and 33% of the food items came from neighbours or friends. In addition, half of the respondents reported collecting wild plants during the six months preceding the interview. From the total of 48 different plant species declared, almost half (23 species) were collected for food purposes, while the other 25 species were collected for medicinal purposes and were also collected more frequently. The findings indicate that urban homegardens and wild space can play an important role in human wellbeing. It is important to incorporate biodiversity and green structures in urban landscape designs to create holistic sustainable cities. However, this requires transdisciplinary collaborations between city planners, ecologists, human nutritionists and ethnobotanists. Highly valuable (and nutritious) plant species should be selected and promoted. Innovative practices should be developed and tested to lift the current barriers and challenges that keep people from growing them. The overall value of gardens and green space should be acknowledged and local knowledge rewarded. These are necessary steps that need to be taken to keep urban gardens and urban green space worthy of being in the city without being thought of as rural or polluted. Most importantly it provides Kampala with an opportunity to remain a leading green Garden City.

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Then of course the stars of the research, Daniel Mulindwa and Joshua Szozi for being in the field with me every long day, as well as Hawah, Lillian, Robin, Brenda and Annet.

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I now look forward to spending time with my friends, the new ones and the old, who are spread out all over the world, I'm going to visit you all.

Lastly, I thank my family for their unwavering love and support.

Dank jullie wel.

Acronyms

BMI	Body Mass Index
DDS	Dietary Diversity Score
FFQ	Food Frequency Questionnaire
FVS	Food Variety Score
HFIAS	Household Food Insecurity Access Score
IDDS	Index Child Dietary Diversity Score
KCCA	Kampala City Council Authority
MIHFP	Months of Inadequate Household Food Provisioning
TLU	Tropical Livestock Unit
UA	Urban Agriculture
UF	Urban Farming
UPA	Urban and Peri-urban Agriculture
WDDS	Women's Dietary Diversity Score
WEP	Wild Edible Plant

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Boxes, Figures & Tables

Authorship

All data chapters in this thesis have been prepared as manuscripts for peer review publications. Since I am by no means the sole contributor to the work documented in these manuscripts, the pronoun 'we' is used rather than 'I' in these data chapters. However, as this is my thesis after all, my contributions to the manuscripts included in this thesis were as follows:

Ch. 4 Mollee, E., Kehlenbeck, K., Mulindwa, D., Ræebild, A., Kindt, R., and McDonald, M.A., (manuscript in preparation). Richness and diversity in urban Uganda: an inventory of Kampala's homegardens.

I designed this study with advice from Katja Kehlenbeck (KK), Morag McDonald (MM) and Anders Ræbild (AR), and collected the data with Daniel Mulindwa. I wrote the first version of the paper which is included here. My overall contribution is estimated to be 95%.

Ch. 5 Mollee, E., Kehlenbeck, K., Ssozi, J, Ekesa, B., and McDonald, M.A. (manuscript in preparation). Diversifying urban diets through homegardens: a contribution to increased fruit and vegetable consumption for food security.

I designed this study with advice from KK and MM and collected the data with Joshua Ssozi. I conducted the statistical analysis with advice from KK. I wrote the first version of the paper which is included here. My overall contribution is estimated to be 95%.

Ch. 6[1] Mollee, E., Pouliot, M., & McDonald, M.A. (2017). Into the urban wild: Collection of wild urban plants for food and medicine in Kampala, Uganda. *Land Use Policy*, *63*, 67–77. http://doi.org/10.1016/j.landusepol.2017.01.020

I designed this study with advice from MM and Mariève Pouliot (MP). I was responsible for data collection with field assistants. I carried out the descriptive, and the statistical analysis together with MP. I wrote the first version of the paper and both co-authors

[1] Chapter 6 has been reproduced with the permission of the publisher Elsevier.

edited it. I was responsible for correspondence with the journal. My overall contribution is estimated to be 95%.

Ch. 7 Mollee EM, McDonald MA, Ræbild A and Kehlenbeck K. (2016). ***Alternative food sources when living in the city: coping with rising food prices in Kampala.*** **Conference Proceedings, Tropentag Conference: "Solidarity in a competing world – fair use of resources", 18-21 September Vienna, Austria.**

I designed this study with advice from MM, KK and AR. I was responsible for data collection with field assistants. I presented the work at the Tropentag conference and wrote the first version of the paper and all co-authors edited it. My overall contribution is estimated to be 95%.

1 Introduction

1.1 Why cities need our attention

Sub-Saharan Africa has the highest urbanisation rate in the world and it is estimated that 50% of Africa's population will be living in urban areas by 2030 (Figure 1.1) (Montgomery 2008; UN 2012; The World Bank 2015), causing serious reasons for concern (Hoornweg and Pope 2016; Satterthwaite and Dodman 2016; Collier 2017). Even though people move to cities in hope for a better future, the reality is that urban poverty is often as bad as or even worse than rural poverty (Kessides and Alliance 2006; UN Habitat 2010; FAO 2012; UN Habitat 2014).

An issue that has been severely underestimated by urban managers is the provision of healthy and nutritious food for this growing population. Expensive fruits and vegetables are the first items dropped from the household diet, resulting in the intake of high calorific staple foods such as maize, cassava, potatoes and rice (FAO 2012). Thus, one of the major challenges is that 'new' urban diets often lack the supplementary nutritional value of traditional food products such as fruits and vegetables, causing severe population health issues due to long-term malnutrition, and resulting in non-communicable diseases such as diabetes and cardiovascular diseases (Popkin 1994; Johns and Maundu 2006; Yang and Keding 2009). Children and pregnant women are especially vulnerable as malnutrition affects infant development (Watson and Pinstrup-Andersen 2010).

Agricultural production is considered an important coping strategy against food insecurity within and around urban boundaries. The production, processing and distribution of agricultural products in urban and peri-urban areas offers the potential for economic development and can enhance food and financial security (Mougeot 2000; Baumgartner and Belevi 2001; Magigi and Drescher 2009). Other urban green resources, such as forests and agroforestry systems in and around cities can also provide the urban population with healthy food products, providing employment and food security (Lwasa et al. 2014). They simultaneously offer other ecosystem services (Figure 1.2) (Millenium Ecosystem Assessment 2005; Wilhelm and Smith 2017) and help mitigate the effects of climate and environmental change (Lwasa et al. 2014). The key emerging areas of adaptation and mitigation in this context include *"enhanced food security, productive greening, ecosystem services and innovative policy for urban resilience and transformation."* (Lwasa et al. 2014). However, empirical evidence of the importance of (urban) biodiversity for ecosystem services is still scarce (Mertz et al. 2007; Wilhelm and Smith 2017) as urban forests and agroforestry systems have long been ignored in forestry and urban & peri-urban agricultural issues (FAO 2011).

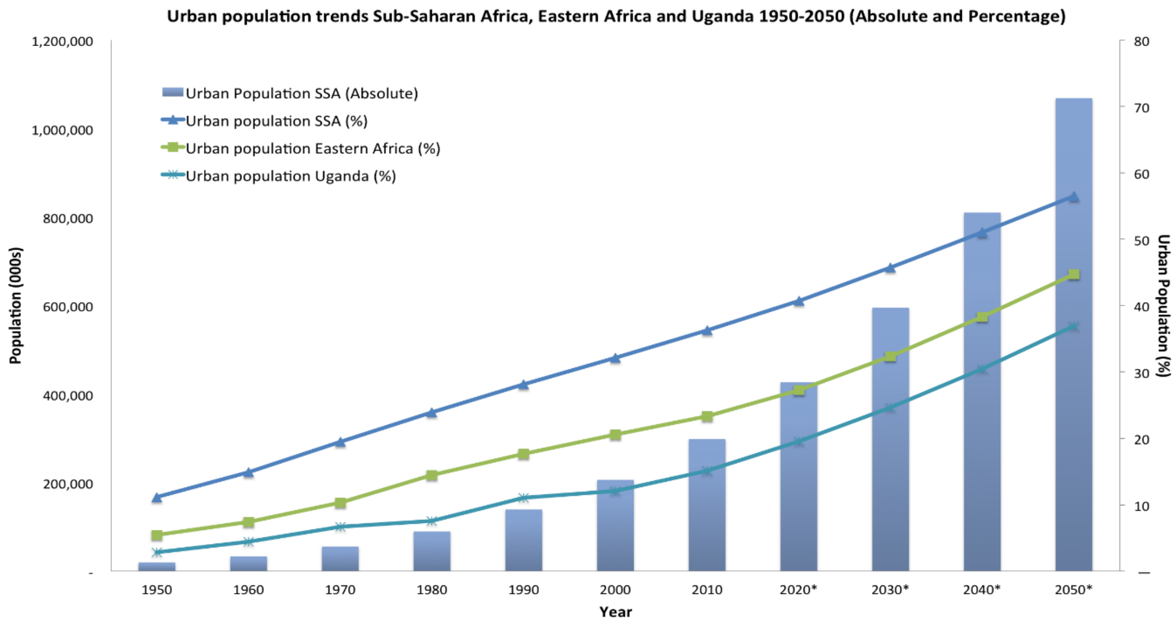

Figure 1.1 Population trends and projections in Sub-Saharan Africa, eastern Africa and Uganda, 1950-2050. Even though eastern Africa shows a lower level of urbanisation than the rest of SSA, rates are increasing in a similar trend. Source:(UN 2012).
*Note: * are projections*

1.2 Research justification

Until recently, urban green space wasn't prioritised for healthy sustainable cities in poorer parts of the world (Penafiel et al. 2011; Sneyd 2013; Wilhelm and Smith 2017). Homegardens were considered rural remnants, which have no place in the urban environment, and urban agriculture was even criminalised in most nations. However the contributions to household food security and livelihoods have been considered important in some countries, for example in Brazil (WinklerPrins and Oliveira 2011) and Uganda (Lee-Smith et al. 2008). The contributions of urban vegetation to provide other benefits such as shade, soil conservation, and mitigation of climate change is a much more recent concern (Lwasa et al. 2014). However, considering urban vegetation in a more holistic and integrated way, including the importance for mental wellbeing and preservation of traditional knowledge is gaining attention (WinklerPrins and Oliveira 2011; FAO 2016).

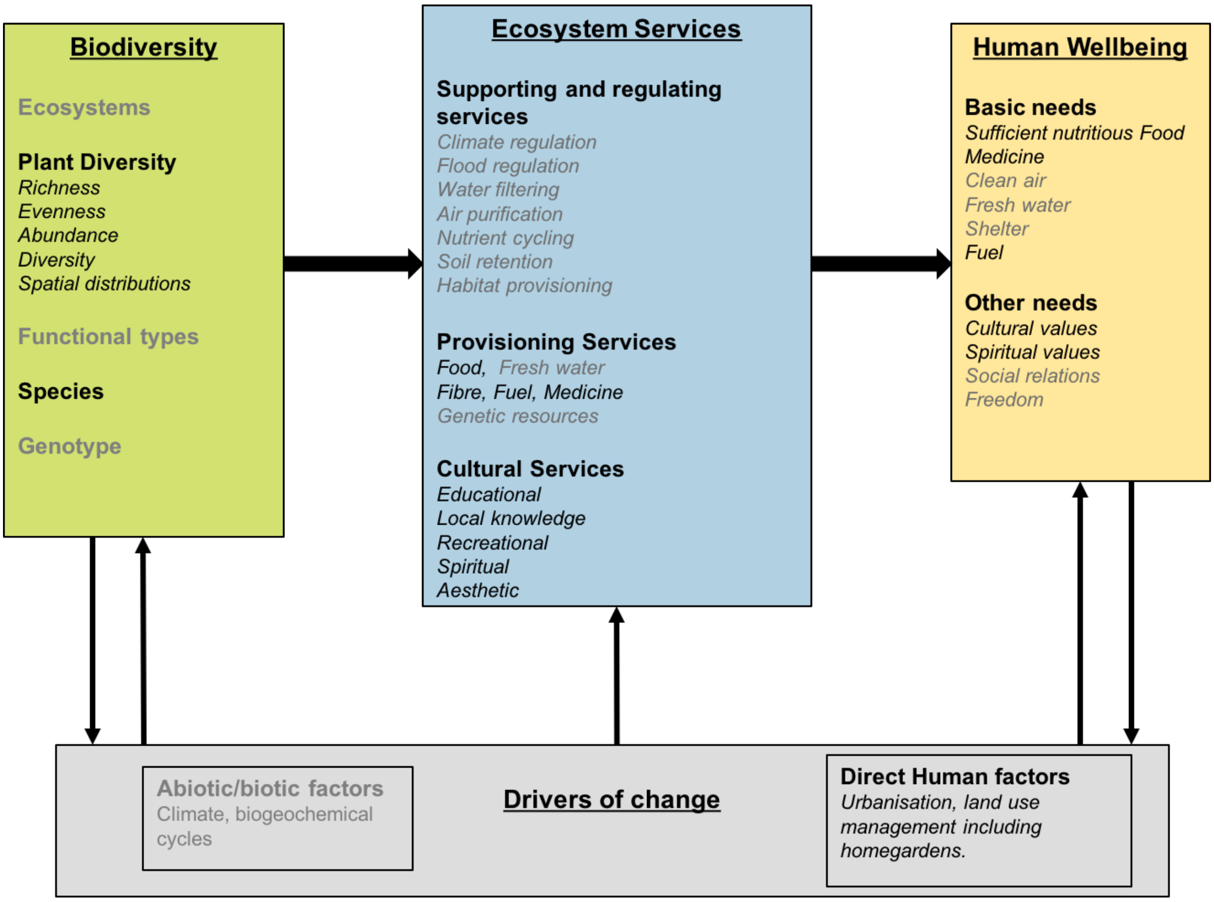

Figure 1.2 Framework of linkages between biodiversity, ecosystem services and human wellbeing that are commonly found, as well as the drivers that influence them. The framework is applicable to the urban setting, where urbanization is one of the biggest drivers of change. The words in black are relevant to this study. Grey words are commonly found concepts within the categories for illustration. It is important to note that drivers do not always have to be negative, but can also improve biodiversity, ecosystem services and human wellbeing. Adapted from (Millenium Ecosystem Assessment 2005) and (Jones 2017).

Urban biodiversity contributes to human wellbeing through many ecosystem services (Millenium Ecosystem Assessment 2005; Lwasa et al. 2014; FAO 2016). Local plants provide basic needs such as food, fuel and medicine as well as cultural needs (Figure 1.2). Urban land use systems that contain biodiversity, including homegardens and public green space, are threatened by the increasing population pressure caused by urbanisation (Vermeiren et al. 2012). They should therefore have a vital role in research before it is too late. Urban homegardens have received much less attention than their rural counterparts. Only scant evidence exists of in-depth studies of urban homegardens (i.e. (Bernholt et al. 2009; WinklerPrins and Oliveira 2011)) as most studies ignore the vast plant richness that is present in the gardens beyond common food crops (Maxwell 1995; Vermeiren et al. 2013).

In Kampala, Uganda, urban food productions systems have been studied for more than 20 years (i.e. Maxwell and Zziwa 1992; Egziabher et al. 1994; Maxwell 1994; 1995; Maxwell et al. 1998; David et al. 2010; Vermeiren et al. 2013). These studies are valuable evidence that document of the importance and history of urban food production (see also Chapter 2). The current study however, looks at the issue through a different lens. It doesn't take the production system as its focus, but rather the overall uses of urban plant resources, including the potential of underutilised, and often indigenous, food plants.

1.3 Aim and objectives

The overall aim (OA) of this study is to provide an understanding of the current and potential contribution of urban plant resources to human wellbeing (in particular food security) in Kampala, Uganda.

To fulfil this overall aim, the study is organised into four objectives, two of which are focused on homegardens in urban and peri-urban parts of Kampala, Uganda. The third objective explores the greater urban landscape, while the fourth investigates urban and rural linkages.

Objective 1

To assess plant composition (species richness and diversity) in selected homegardens of urban and peri-urban Kampala.

Research Questions:

- Which socio-economic and geographical factors determine species richness and diversity?
- Which use categories are derived from homegardens?
- How do homegardens provide circa situ conservation purposes for underutilized and indigenous species?

Objective 2

To explore associations between homegardens and socio-economic determinants of dietary diversity and fruit consumption of children (aged 2-5 years).

Research Questions:

- What is the nutrition status, dietary diversity and fruit intake of children and female caretakers?
- What is the relative contribution from home production to overall consumption?
- Do children with higher garden edible plant richness and diversity have better dietary diversity and fruit consumption?

Objective 3

To explore the scope of collection of wild plants in Kampala, Uganda.

Research Questions:

- What characterises collectors of urban wild plants?
- Which plants are collected and for what use?
- Where and in what type of locations (public or private) does urban collection of wild plants take place in the urban and peri-urban environment?
- Does urban collection of wild plants function as a safety net?
- What are people’s attitudes and perceptions regarding urban collection?

Objective 4

To assess the extent and importance of alternative food sources of different food groups for low-income residents in Kampala, Uganda.

Research Questions:

- What type of food products do people grow in their gardens?
- What type of food products are sent by friends and relatives from rural areas?
- What type of food products are collected in the urban environment?
- What type of food products are collected in the rural environment?

1.4 Ultimate beneficiaries and key actors

This study is applied in nature and is ultimately aimed at helping to improve the status urban low-income households in Uganda who face nutritional and health problems. Therefore, besides the empirical contributions of this study to the academic body of knowledge, this study further aims to inform key actors to help them make informed decisions on urban ecosystems as well as urban food security. The multidisciplinary nature of the research provides an opportunity to engage actors from a variety of fields in a shared mission of creating sustainable and healthy cities. These key actors are, among others, government and city council officers concerned with urban green space, climate change and its linked resilience, as well as nutrition workers within government and donor agencies. Furthermore, researchers in nutrition sensitive agriculture and agroforestry are encouraged to participate in further exploration of the role of urban plant resources for human wellbeing, both in as well as outside Uganda.

1.5 Structure of the thesis

Chapter 2 provides a detailed description of the research context. Kampala has a long history with urban food production and it is worth understanding how this study adds to the context of Kampala specifically. The literature review in **Chapter 3** gives an overview of the existing literature of the different disciplines addressed in this thesis, how they fit together and where the main research gaps exist. The next four chapters are the data chapters, each written as a standalone manuscript addressing one of the research objectives (Table 1.1). In **Chapter 4** the plant composition of the gardens included in this study are described, such as species richness, density and diversity. The different uses of the species are reported and variation in plant composition between inner, outer and peri-urban areas is tested. Furthermore, socio-ecological and environmental determinants of garden composition are examined. Then **Chapter 5** provides more detail on the edible plant species found in these gardens and their (potential) contribution to household food security. This chapter further focusses on specific food and fruit consumption with the main emphasis on child nutrition. In **Chapter 6** I look at collection and use of urban plant species from the urban landscape outside of people's own gardens. While **Chapter 7** goes even beyond the city's boundaries, this short chapter compares the different alternative food sources that people use to acquire their foods other than from markets. In **Chapter 8** I provide a general discussion and link the findings from the different chapters with each other to give a general conclusion in **Chapter 9.** Lastly, in **Chapter 10** I provide a critical assessment of the work and conclude by providing recommendations for areas of further study.

1.6 Compliance with ethical standards

This study was conducted according to all prevailing national and international regulations and conventions. As such, scientific ethical practices regarding the involvement of people have been respected and the study was approved by Bangor University Ethical Review Committee as well as by the Uganda National Council of Science and Technology under reference no. ADM 154/212/01.

Table 1.1 Overview of methods

Chapter	Refers to Objective	Main academic disciplines	Methodological approach	Data used	Collection instruments used[2]	Data analysis
Chapter 3	OA[3]	Agroforestry/ Ethnobotany/ Human nutrition/ Urban agriculture/ Urban forestry	Desk study	Literature	n.a.	Descriptive, literature review
Chapter 4	OA 1	Plant Ecology/ Land use	Observational: Questionnaire & Botanical inventory	Botanical inventory, Socio-economic data, Urban farming practices	1 & 2	Descriptive, Shannon-Wiener Index, Evenness Index, logistic regression, multivariate stepwise regression, Chi-Square tests, t-test, ANOVA and post-hoc Tukey's, Kruskal-Wallis (H) and Mann-Whitney's (U) tests, Pearson and Spearman correlation
Chapter 5	OA 2	Human nutrition/ Food and resource economics	Observational: Questionnaire & Botanical inventory	Botanical inventory of food plants, socio-economic data, repeat 24-hour recall (DDS & FVS), anthropometric measurements, HFIAS	1, 2 & 3	Descriptive, Shannon-Index, Evenness, logistic regression, Mann-Whitney's (U) tests, Spearman and Pearson correlation
Chapter 6	OA 3	Ethnobotany/ Land use	Observational: Questionnaire	Socio-economic data, collection questionnaire	2 & 3	Descriptive, PROBIT logistic regression (Binomial GLM)
Chapter 7	OA 4	Human nutrition/ Food and resource economics	Observational: Questionnaire	Botanical inventory, alternative sources questionnaires.	1 & 3	Descriptive, radar diagram

[2] Households were visited three times, the collection instruments used (referred to as part 1 to 3) are presented in Annex 1.
[3] OA = Overall Aim

2 Context and background

2.1 Kampala: A city in development

“The inherent potential and beauty of the City’s topography and of Lake Victoria has barely been appreciated or utilised. Nonetheless, Kampala still retains significant natural values and still grants the potential for the City to develop as a City of Quality, a “green” City, utilising its natural potential to provide amenity for its residents.” (KCCA 2012).

Uganda’s capital city Kampala (0°19'N, 32°35'E) (Figure 2.1) is situated in the Lake Victoria Crescent agro-ecological zone. It has an annual bimodal rainfall pattern which averages between 1750 and 2000 mm per year and the average temperature is 23°C (The World Bank 2015). The larger region has medium to highly fertile soils and is subject to intensive banana and coffee production systems. However the market of other crops is increasing, such as sweet potatoes and maize (Mwebaze 2006). The potential vegetation type can be classified as *Lake Victoria drier peripheral semi-green Guinea-Congolian rain forest* (Kindt et al. 2011).

Figure 2.1 Map of Uganda with location of Kampala on the shores of Lake Victoria.

Over the past three decades, Kampala has experienced an annual growth rate of about 4% to its current population level of almost 1.9 million (CIA 2016). This has caused the city to increase the total built-up area from 71 km^2 to 386 km^2 (Vermeiren et al. 2012) and hence the disappearance of much of the city’s green areas. Increase in heavy rainfall due to climate change is already occurring and is predicted to cause even more damage in the future (Baastel Consortium 2015). This combination of increased rainfall intensity and clearance of vegetation on the city’s hills causes severe flooding, which affects mainly the vulnerable poor in the valleys and wetlands.

As a rapidly growing city, Kampala has suffered from price increases for basic goods and services over the past 10 years (Figure 2.2) (Sabiiti et al. 2014), however the price of food has been increasing more steeply than any other commodity. Even though the abundance of urban markets supply fresh foods year-round, the high prices make it inaccessible to many low-income residents (Collier 2017).

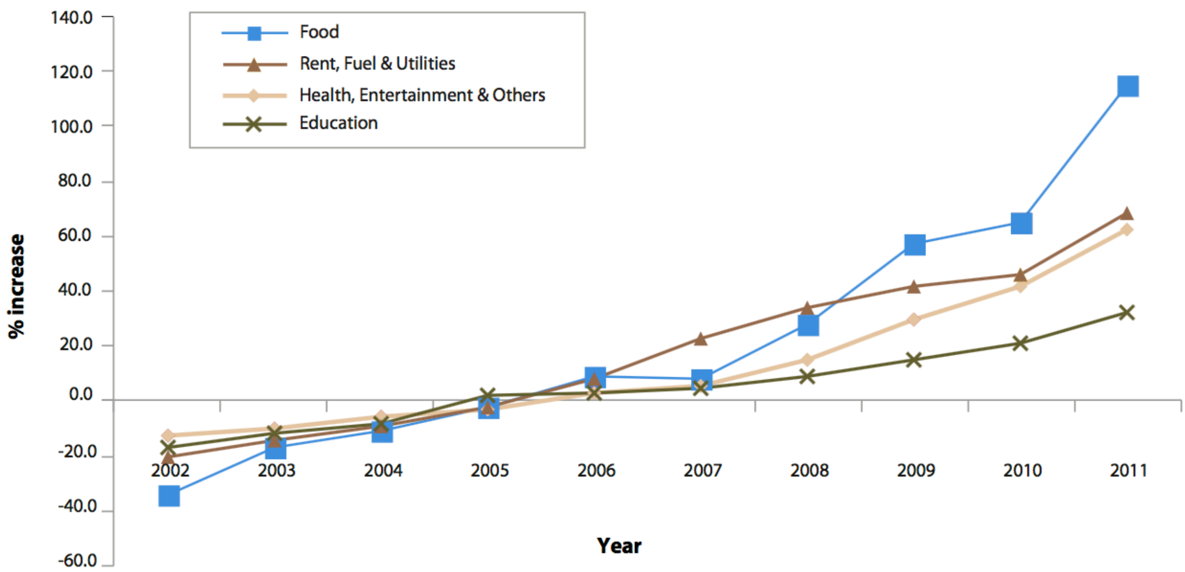

Figure 2.2 Increase of prices of basic goods and services for Kampala (Sabiiti et al. 2014)

2.2 A pioneer in urban food production

Kampala has had a long history of urban food production (Table 2.1 and Annex 2). As a capital city it has attracted a diversity of tribal communities and thus forms a melting pot of Ugandan cultures and foods, however most of Kampala's citizens are still Baganda people (who speak Luganda). Systematic research of Kampala's food production systems goes back to the early 1990s. Studies by Maxwell et al. (Maxwell and Zziwa 1992; Egziabher et al. 1994; Maxwell 1994; 1995; Maxwell et al. 1998) and later by David et al. (2010), provide rare documentations of reliable estimates of the extent of urban agriculture (UA) in Kampala. Maxwell's (1994) numbers ranged from 25% (for a sample of low income households with children) to 36% for a non-representative sample of households in different parts of the city (Maxwell 1994).

Table 2.1 A timeline of Kampala's academic and policy history with urban food production.

Period	Details
Pre - 1990s	Urban farming was a practice culturally rooted within the Baganda society and encouraged by the *Kabaka* (the King) (Okuku 2006). This meant that the British colonialists who wanted to remain in favour with the *Kabaka* had no other choice but to tolerate this land use system (see also annex 2). The Kampala city council was unique compared to other countries in the region in this aspect. Especially when during the economic crises of the 1970s, urban farming became even more prevalent.
1990s	Maxwell and Zziwa were the first to study urban agriculture (UA) in Kampala in a structured way (Maxwell and Zziwa 1992). They described how UA provided livelihoods, and formed a food source for an increasing number of urban dwellers. A follow-up study demonstrated that at least one third of Kampala's practices remained undocumented (Maxwell 1995; Maxwell et al. 1998). Their findings included that children of urban farmers were less stunted than those of non-farming families (Maxwell et al. 1998) and that urban agriculture functions as a safety net (Maxwell 1995).
2000s	During the 2000s, the special relationship Kampala had with urban food production was still recognised. The city was included in two related international projects *Urban Harvest* and *Healthy City Harvests* (Cole et al. 2008; Prain et al. 2010). These projects were characterised by a multidisciplinary approach and aimed at identifying the links between urban agriculture and food security using food insecurity indicators, anthropomorphic measurement indices and 24-hour dietary diversity scores. The focus of these projects was on livelihoods and production systems, including market opportunities. Furthermore, this programme resulted in a special Department of Urban Agriculture within the city council. Even though urban agriculture had been tolerated until then, the city council now finally approved a set of ordinances that legalized urban agriculture (Lee-Smith et al. 2008).
2010s - now	In 2011, the Kampala city council underwent a major reorganisation. The urban agriculture domain was removed as a department and now falls under the Department of Gender, Community Services and Production. Even though it is no longer one of the core functions of the city council (KCCA n.d.) promotion of UA and training of communities in UA practices still occurs. As well as research into pig breeding, hydroponic barley fodder and vegetable gardens at their research and training farm in Kyanja (a neighbourhood in Kampala)(Epilo 2016). Moreover, a new dimension has been given to the broader discipline as the city envisions itself to become a "vibrant, attractive and sustainable city". The Department of Physical planning, therefore, is dedicated to increase urban greening and tree planting (KCCA 2016), including the inclusion of edible and indigenous species (Ssanyu 2016).

While David et al. (2010) found that the numbers are quite geographically depended and accentuate how urban and peri-urban locations can have important differences in their role in UA. The proportion of households engaged in UA in urban Kampala was on average found to be 26.5% while 56.2% in peri-urban Kampala. This means that twice as many households are engaged in UA in peri-urban areas compared to urban areas. However it should be noted that this latter study only looked at few neighbourhoods in the city and can't be extrapolated to count for Kampala city as a whole (David et al. 2010).

2.3 Urban farmer typologies

Maxwell (1994) identified four urban farmer typologies in Kampala: 1) *Commercial farmers*, 2) *Food self-sufficiency*, 3) *Food security*, and 4) *Survival* (Maxwell 1994). These four typologies roughly follow a wealth class ranking and reflect the importance of farming in the urban context, from a survivalist's needs to a commercial endeavour. Vermeiren et al. (2013) in their study of urban farmers in Kampala, identified similar classes via a cluster analysis, 1) *Commercial farmers*, 2) *Garden farmers*, and 3) *Subsistence farmers* (Vermeiren et al. 2013); where *Survival* and *Food security* farmers are combined under the *Subsistence* umbrella. What is clear from Maxwell's (1994) study is that most of the respondents fell into the two low income groups, and in both studies commercial farmers were a minority and found predominantly in the peri-urban periphery.

A third study by David et al. (2010), conducted between 2002-2004, again showed similar typologies: 1) C*ommercial*, 2) *Semi-commercial*, and 3) *Subsistence* farming. However what distinguishes David et al. (2010) from the other two studies is that they based their design on demographical differences: Urban old (Bukesa), Urban new slum (Banda), Peri-urban in transition (Buziga) and Peripheral Peri-urban (Komamboga)[4] (David et al. 2010). The literature is often ambiguous in the use of urban and peri-urban concepts, but David et al. (2010) tackled this problem head on by identifying

[4] These types were identified through stakeholder meetings and with involvement of the local governments.

four "stages" of urbanisation (old, new, in transition, peripheral). Using this approach made it possible for the researchers to come to the following conclusions:

"An urban agriculture gradient exists with farming households constituting a lower proportion of all households in urban areas and a higher proportion toward the periphery";

"Overall, percentages of urban farming households (roughly 49 percent, but possibly even more) may be higher than previously measured because more space is occupied by peri-urban than urban areas due to the concentric spatial pattern of the city (although densities are lower)"

(David et al. 2010)

In addition, differences were found in crop and livestock production systems, making it possible to identify types of urban farming systems along the gradients. They then continue by stating that "*according to the farmers themselves, in 2003, there were food self-sufficient producers everywhere except the old inner urban area, and they were rich or middle class. By contrast, food security producers were found in all areas, but they were rich or middle class in the old urban area, middle class in the urban slum and poor in the peri-urban areas.*" (David et al. 2010).

2.4 Urban food production systems

The studies discussed above have been addressed through the lens of food production systems specifically, using urban agriculture and urban farming concepts interchangeably. The definition between the various concepts of food producing systems is ambiguous and often not well defined (Drescher et al. 2006). Since the present study uses a more ecological approach by including all plant species, I decided to look at homegardens specifically since species richness and diversity are high. This rationale is further explored in the next chapter (Chapter 3). Figures 2.3 – 2.7 provides an illustrative insight into the differences in land use systems considered.

Figure 2.3 Agriculture brought to the city. Crops are cultivated on beds in a wetland away from the homestead, there is little diversity and often poor land security (source: the author).

Figure 2.4 A highly diverse homegarden in inner Kampala that is used as a demonstration garden to train people on production techniques in limited space (source: the author).


Figure 2.5 A homegarden in peri-urban Kampala with livestock (source: the author).


Figure 2.6 A typical homegarden in inner urban area of Kampala (source: the author).

Figure 2.7 Collection from the wild. Children collecting leafy green vegetables on an abandoned plot (source: the author).

2.5 Nutrition, health and wellbeing in Uganda

In rural Uganda, 30% of the children under the age of five are stunted while 10% is even severely stunted. This causes serious reason for concern as stunting is an indication of chronic malnutrition. Even though these numbers are lower for urban children under the age of five, 24% and 7% respectively (UBOS and ICF 2017), there is still reason for concern. Urban data on child malnutrition is rarely disaggregated, so precise numbers on how affected children in low-income families are and what the precise root of the deficiencies are can only be estimated.

A SWOT analysis (Table 2.2) of two different approaches shows that whereas there are potentially more efficient ways of improving child nutritional status through biofortification, food additives and/or school meals, urban vegetation can provide a more overall improvement to human wellbeing.

Human wellbeing is a concept that is used in many disciplines. The Cambridge dictionary[5] defines it as "The state of being healthy and happy". While the term can be applied to different fields, including for example mental wellbeing (psychology), in this study it is used to refer to basic needs such as food and medicine mainly (Figure 1.2). Those commodities that are needed to, at least, live a physically healthy life. However, in some parts of the study other elements are also touched upon, as they are intrinsically linked to urban vegetation and homegardens in particular. These include

[5] http://dictionary.cambridge.org/dictionary/english/well-being, last accessed 13 June 2017.

ornamental plants, fuel as well as cultural and spiritual values that improve a person's wellbeing.

Table 2.2 A SWOT analysis of two approaches to tackle child malnutrition in an urban environment, through 'alternative nutritional improvements' such as food additives and school meals and 'urban plants' such as homegardens and wild plants.

	SWOT element	**Alternative nutritional improvements (food additives, school meals etc.)**	**Options for using urban plants**
Internal	**Strengths**	• Can be more universal (All children can be reached) • Can be very specific and tailor-based depending on deficiency • Quick and effective method	• Easy accessibility • Potential to provide fresh produce year round • Provides multiple ecosystem services for human wellbeing, not only nutrition
	Weaknesses	• Costs • Top-down approach • How does it improve people's awareness? • Do people adopt new biofortified cultivars easily (e.g. orange fleshed potato)?	• Urban pollution poses a health risk • Only limited access (not everyone has access everywhere)
External	**Opportunities**	• Improved biofortified cultivars bring new business opportunities	• Enhances/improves urban green • Help provide (additional) income
	Threats	• Risk of end of funding or government policy changes (school meals). • Risk of multinational corporations owning patents.	• Vegetation is disappearing due to high urbanisation rates • Prone to effects of climate change, pests and other outside factors

3 Literature Review: The potential for healthy diets from across the urban landscape

3.1 Introduction

"Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Household food security is the application of this concept to the family level, with individuals as the focus of concern." (FAO 2003; UN Habitat 2010).

Urban food security remains one of the major challenges faced today (IFPRI 2016). Despite FAO's warnings of the fast-growing group of people among the urban poor suffering from malnutrition 15 years ago (FAO 2001) the issue remains a priority (IFPRI 2016). The aim of this literature review is to explore the potential of the urban landscape to contribute to healthy urban diets. Key questions that drive this literature review are:

1. What are the key nutritional problems and how do they differ between urban and rural areas?
2. How can urban plant diversity contribute to improved urban food and nutrition security?
3. Which research gaps can be identified?

I will first provide an overview of the extent of urban malnourishment, how it functions and why the current approaches don't work. I then explore the option of how the urban landscape could be part of the solution. I will discuss urban and peri-urban agriculture (UPA), urban forests (UF), urban and peri-urban agroforestry (UPAF) and how indigenous fruits may serve as an unlikely hero. Finally, I will discuss these opportunities and challenges for further study.

3.2 Urban diets, malnutrition and sectorial approaches

Urbanisation enhances a nutrition transition, where people shift from a traditional diet, to one which is rich in refined starches, oils and sugars (Popkin 1994; 2000; UN 2012). This shift to more processed foods leads to an increase in overweight and obesity numbers. Mendez et al. (2005) demonstrated that in the 1990s in 19 Sub-Sahara African countries, the number of women between 20 and 49 years who were overweight exceeded the number of underweight significantly and almost one third of African women in cities were overweight compared to 14% in rural areas (Mendez et al. 2005; Seto et al. 2012). Although this nutrition transition exists in rural areas also, it is more prevalent in cities and forms a serious health threat to the urban population if no action is undertaken. A rising population of overweight and obese people brings about an increase in numbers of non-communicable diseases such as diabetes and cardiovascular conditions (Popkin 1994; Johns and Maundu 2006; Yang and Keding 2009). Obesity is caused by overnutrition, which refers to "an excess of dietary energy requirements". While undernutrition is "the result of food intake insufficient to meet dietary energy requirements, either through poor absorption and/or poor biological use of nutrients consumed", both can exist close together and are called malnutrition. According to FAO, malnutrition is "an abnormal physiological condition caused by deficiencies, excesses or imbalances in energy, protein and/or other nutrients." (FAO 2012; FAO et al. 2012). Malnutrition can appear in several forms such as hunger and hidden hunger. Malnutrition through hidden hunger is harder to detect as someone can appear to be healthy from the outside, but has a lack of vital micro-nutrients, minerals and/or vitamins. Children and pregnant women are especially vulnerable as malnutrition affects infant development. Malnutrition is responsible for more than half (54%) of the documented deaths of children under five in the developing world (Popkin 1994; Gordon et al. 2005; Johns and Maundu 2006; Watson and Pinstrup-Andersen 2010).

The main nutrition deficiencies in the developing world are Vitamin A, zinc and iron shortages. Vitamin A deficiency in children can lead to visual impairment, blindness and even death as it makes them more vulnerable to die from illnesses such as diarrhoea and measles (Yang and Keding 2009; Watson and Pinstrup-Andersen 2010). It specifically affects young children and pregnant or lactating mothers as these essential nutrients are needed to develop and support the visual system as well as growth, epithelial integrity, red blood cell production, immunity and reproduction (UNICEF 2004; WHO 2009; Watson and Pinstrup-Andersen 2010). In Sub-Saharan

Africa (SSA) almost half of all preschool children (< 6 years old) are affected, ranging from 17% (Mauritania) to 70% (Benin and Kenya) between countries (UNICEF 2004). Even more prevalent in SSA is iron deficiency, it causes poor growth and development of young preschool children. The rate of affected children varies between 37% (Botswana) to 86% (Sierra Leone) (UNICEF 2004). The third major deficiency on the continent concerns Zinc, approximately a third of the adult population suffers from this deficiency, ranging from 'only' 9% (Niger) to 61% (Mozambique). Zinc shortages affect bone growth, metabolism and mental growth and stability (IZiNCG 2004). The levels of nutrient deficiencies differ strongly between countries, however in practice they often overlap and interact, causing children to suffer from several health issues simultaneously (UNICEF 2004).

Disaggregated data of urban malnutrition levels are hard to find or simply even lacking. Country data often shows slightly lower stunting levels (as defined by height-for-weight which indicates chronic malnutrition) in urban children than in rural children, however within urban variation can be expected to be higher than in rural areas. The importance of this information can be illustrated with data from Indonesia and Bangladesh, which shows that malnutrition in slum areas is higher than in rural areas, and also compared to the total urban area (WHO 2013). However, the limited availability of disaggregated nutrition data makes it more difficult to estimate the prevalence of these nutrient shortages in urban areas. This signifies that cities are complicated cases and that urban poor are vulnerable and in danger of being overlooked by nutrition studies and programmes.

Moreover, current food systems are dysfunctional as they do not deliver enough essential nutrients to meet the recommended requirements of everyone (Graham 2007; DeClerck et al. 2011). FAO data on available food groups show that the production of starchy roots has increased 3.5 times whereas the production of fruits has only increased 2.3 times in the past 35 years (Herforth 2010a; FAO 2013). This indicates that more effort has been put into providing more calories, as opposed to providing more nutrient rich foods. More effort should be put into researching and promoting more nutritious diverse food products such as fruits and vegetables. When solving malnutrition is the challenge, linking the source of nutrients with human health is the approach that should be used. Much can be gained by looking at agricultural practices in a more nutrient sensitive approach. One means to reach this is through dietary diversification (DeClerck et al. 2011).

Health is strongly linked to diet and a balanced diet is characterised by dietary diversity, therefore studying dietary diversity can be used as measure for household food security. Smith and Alderman (2006) found that that from twelve countries in Sub-Saharan Africa, 8% to 63% of the households were found to consume low diverse diets, which meant they only consumed fewer than four out of seven food groups (Herforth 2010a). A longitudinal study of smallholder farmers in Kenya and Tanzania shows that the number of crops cultivated, was strongly linked to dietary diversity (Herforth 2010b). However studies like these are rare and often anecdotal, a point also raised by Jaenicke and Virchow (2013), who conclude that more monitoring research is needed to establish proper development programmes.

Studying dietary diversity could also be approached from an ecological point of view, resulting in biodiverse diets. DeClerck et al. (2011) found that functional agrobiodiversity practices can contribute to environmental sustainability as well as human health through improved nutrition. This means that conservation, environmental sustainability and human nutrition should be considered in a more holistic approach. Inappropriate techniques based on unsustainable management practices can lead to soil erosion and water scarcities, which leads to poor yields and thus nutrition insecurities. In many places in the world human nutrient deficiencies are directly correlated with soil deficiencies. Herforth (2010a) names the different environmental components that affect human nutrition, i.e. biodiversity, soil, water, climate and ecosystems. For example, soil is not only important for crop yield, but also determines the mineral content of the food. Sustainable natural resource management practices are of thus of vital importance to ensure nutrition security (Graham et al. 2007; Herforth 2010a; DeClerck et al. 2011).

Another limitation in traditional food studies, is that they show information of common food crops available only, which gives little information about ‘real’ diets and nutritional intake, as it ignores the lesser consumed food products. Only very small quantities of some nutrients are needed, but if not consumed it can have serious health consequences, yet these can easily be overlooked. The use and consumption of traditional, wild, or local crops have long been ignored in scientific studies, country surveys and global databases. However, recently an increasing amount of studies and programmes focus on the value of these ignored or underutilised foods (Leakey et al. 2004; Goenster et al. 2011; Jamnadass et al. 2011; Kehlenbeck et al. 2011). An example of a successful adopted policy that shows an increase in consumption of traditional nutrient rich crops is one where the Kenyan Ministry of Agriculture recognized the potential of traditional vegetables. Bioversity International has worked with the National Museums of Kenya to bring back the traditional African leafy vegetables. These nutrient rich crops are often less labour intensive and need less fertilizer to grow, thus they are cheaper to grow (Irungu et al. 2007). This shows that the potential importance of these foods for health and ecosystems services is gaining more acknowledgement.

Despite the obvious links between foods and health, agricultural and health policies could not be more isolated from each other. The lack of cooperation between the agricultural and health sectors results in missed opportunities. Improvements in income levels are directly linked to health and this is especially the case for low income households (Mackenbach 2005). A per unit increase in income directly affects health and thus well-being of the poor. This could mean a way for people to escape the poverty trap, where poor nutrition causes poor educational performances, which in turn reduces a person's chances on the job market, and forces people to remain in unskilled labour jobs or even unemployment. For people trying to move out of poverty, who are then unable to feed their children a healthy nutritious meal, this cycle continues into the next generation. Combining sectors and research disciplines helps not only achieve Millennium Development Goal 1 (MDG 1) – eradicating extreme poverty and hunger, but can also contribute to reaching MDG 4 (reduce child mortality), MDG 5 (improve maternal health), MDG 6 (combat HIV/AIDS, malaria and other diseases) and MDG 7 (ensure environmental sustainability) (Braun et al. 2010). This approach asks for new ways of doing research in unfamiliar territory and to look at problems and solutions more holistically. Breaking the poverty trap by overcoming the malnutrition trap could increase rates of success in more than one discipline. Interdisciplinary approaches in developmental issues form the challenge for combining the fields for urbanisation, nutrition and agronomy.

3.3 Potential from the urban landscape

To challenge 'the urban malnutrition trap', there is a need for more fresh, nutritious, safe and affordable foods. It also means that urban food systems should become less dependent on food imports, less vulnerable to price increases and more resistant to climate change impacts. The use of traditional species not only fights the issues of poverty and food security, but also helps solve malnutrition (Jamnadass et al. 2011). An integrated systems approach for food production should be explored when aiming for healthy sustainable food systems, this includes looking at ecological interactions with the natural environment (Powell et al. 2015). Furthermore, biodiverse production is not only important for a diverse nutritious diet, it generally also improves productivity, enhances ecosystem functions and provides adaptability (Frison et al. 2011). Fruits and vegetables are high value food crops. They are high both in economic as well as nutritional value. Exploring how these crops can be used and cultivated in and around cities is a vital cog in improving urban nutrition. From an urban landscape perspective, *urban and peri-urban agriculture*, *urban forestry* and *urban homegardens* are classified as systems that could be considered as sources to improve urban nutrition. Although these systems are not necessarily mutually exclusive, and overlap can be found between them, they are here discussed separately to emphasise their specific characteristics.

3.3.1 Urban and Peri-Urban Agriculture (UPA)

With large-scale urbanisation, agricultural production is considered important both around and within urban boundaries of developing countries. The production, processing and distribution of agricultural products in the urban and peri-urban area offers the potential for economic development and can enhance food and financial security (Mougeot 2000; Baumgartner and Belevi 2001; Magigi and Drescher 2009). About 30% to 40% of the urban population in Sub-Sahara Africa is in some way involved in urban agriculture (Maxwell 1995; Maxwell et al. 1998; FAO 2012). Most farmers cultivate cereals and root crops, which, as explained above also, are excellent sources of energy, but are poor in micronutrients.

Urban and peri-urban agriculture (UPA) refers to any form of food production in cities, this includes sack gardening (mainly in slums), allotments, backyard farming as well as the use of any open 'available' space for planting food crops (Drescher et al. 2006). UPA can help tackle poverty and malnutrition challenges by diversification of the food supply and reduce vulnerability to economic or climatic fluctuations. Despite acknowledgements that urban farming can actually form "an important component of urban development" (Brundtland 1987, p254), it is still not fully integrated into urban spatial planning in most countries (Magigi and Drescher 2009).

However, urban agriculture remains a much-debated topic, mainly because specific data on quantity and quality is usually limited. Many studies are described in grey literature only, practices often take place in informal settings and there is a high production rotation. Documentation is usually aimed at establishing how much the practice contributes to household livelihood strategies, and ignoring the nutritional benefits to food security. Moreover, most studies cover staple crops only and do not include specified data of tree products such as fruits, and are of poor design (Box 3.1) (Poulsen et al. 2015; Warren et al. 2015).

Urban farmers are challenged differently from their rural colleagues. Whereas soil fertility issues often limit production in rural areas, space is the main constraint in cities. Evidence from Schreckenberg et al. (2006) indicates that fruit tree density increases as farm size decreases, suggesting that since urban farmers typically have little space in their homegardens, fruit trees form an ideal crop for improving domestic food quality and household cash income as they epitomise the concept of 'vertical production'. Additionally, trees have deep, extensive root systems, which can hold soil to prevent erosion. They are welcomed by forward-thinking city planners as they help 'pump' excess water from the soil that otherwise could lead to flooding. Typically, poor neighbourhoods are situated on lower slopes and in valleys, areas that are vulnerable to floods.

However, urban farming is not all as promising as it is sometimes described to be. Urban pollution and space constraints can form severe health hazards also. Much of urban farming occurs on fringes, in wetlands and other locations. In Uganda, encroachment on wetlands causes loss of wetland vegetation. This not only removes the natural buffer around Murchison Bay and letting heavily polluted wastewater streams into Lake Victoria (Isunju and Kemp 2016), the toxic particles are also taken up by food crops and consumed by the people causing severe health issues (Serani et al. 2008; Fuhrimann et al. 2016).

Box 3.1 Characteristics and issues in Urban Agriculture (UA) studies (adapted from and based on literature reviews by (Poulsen et al. 2015; Warren et al. 2015))

General characteristics of UA:

- Most Urban Agriculture is subsistence based.
- Financial motivations form a second motivator.
- Both subsistence and financial motivations indicate the high value farmers place on UA as a practice and how much they (feel they need to) depend on it.

Empirical evidence on the link between UA and Food Security is inconclusive, this is partly due to the high variety of designs and different aims of studies, among the issues are:

- There is a lack of <u>seasonal</u> information
- Ambiguity in definition of <u>food security</u> (i.e. level nutritional detail, such as types of food groups, vitamins etc. or simply calorie-based)
- Lack of proper <u>health indicators</u>
- Lack of studies containing <u>dietary quality</u>
- Ambiguity in food security/insecurity indicators

Moreover, urban farming is often still practiced by growing known common crops in a similar way to rural areas, however since the challenges in the urban area are different, new innovative practices adapted to local conditions are essential. Vertical and sack garden farming systems as well as aquaponics and rooftop farming are innovative ways to address the urban challenges of farming in the city. However, there is still much room for improvement for urban innovation and choice of crop species to adapt to an efficient urban agricultural future.

3.3.2 Urban Forestry (UF)

Wild forest food products provide many traditional rural communities in the developing world with healthy food products, providing employment and food security (Garrity 2004; Schreckenberg et al. 2006; Vinceti et al. 2008; Yang and Keding 2009; Kung'u 2011; Shackleton et al. 2011a). Forests in and around cities can provide similar benefits to urban communities, however, they are largely ignored in forestry issues (FAO 2011). Communities that live in or close to forests are often better at avoiding diseases and their food sources are more resilient to pests and climate shifts (Johns and Maundu 2006). Incorporating this type of knowledge and using these food sources sustainably in and around cities can contribute to the health and livelihoods of people in an urbanising world.

Trees in the urban environment - which is a short, general and concise definition of urban forestry (Konijnendijk et al. 2006) - also have important ecological functions, providing shade, regulating microclimates and housing wildlife such as birds and bats. Furthermore, trees also provide shade, sequester carbon, prevent soil erosion, protect citizens from the effects of floods and filtering waste water run-off, influence local climate and need very little maintenance compared to more labour intensive crops (Arnold and Dewees 1998; Noordwijk et al. 2011). Mougeot (2005) describes that with higher density populations in central urban areas, small open areas should be used for more capital intensive forms of urban agriculture, such as growing fruit trees and medicinal shrubs, while more land intensive and waste generating forms should relocate to lower population density locations (Mougeot 2005, page 12).

However, original (or old) forests have disappeared in many cities. The challenge in urban forestry is that trees take a lot of initial financial investment and patience before benefits can be taken from them. In addition, urban space is limited and to plant, maintain and conserve trees, whether it is in private or public space, takes dedication and persuasion from multiple actors.

3.3.3 Homegardens

Homegardens are some of the oldest land management practices contrived by humans and are even considered the "epitome of sustainability" by some (Torquebiau 1992; Doolittle 2004; Kumar and Nair 2004). As a specialised agroforestry system, homegardens function as highly diversified niches (Galluzzi et al. 2010), and can survive in larger degraded landscapes, forming islands of biodiversity in areas suffering from biodiversity loss caused by natural phenomena such as droughts, or more direct human influences as deforestation and urban development. Due to their complex systems and high variabilities there is not one simple definition to describe them. However, those that exist have common features between them and the consensus remains that: "*a homegarden is a small scale, supplementary food production system by and for household members that mimics the natural, multi-layered ecosystem*." (Hoogerbrugge and Fresco 1993), and sometimes in association with domestic animals (Kumar and Nair 2004). There are, however, a few important features that characterise homegardens specifically (Box 3.2)

Kumar (2008) argues that urban homegarden systems can form a "pseudo-forest" within cities: conserving biodiversity while providing fruits, vegetables, nuts and herbs for local inhabitants. This constitutes an untapped resource overlooked in many urban planning processes, as they can offer enormous contributions to health, livelihood and biodiversity conservation (Kumar 2008; Akrofi et al. 2010). By cultivating healthy, indigenous nutritious food products locally, it not only takes away the burden of commercial harvesting elsewhere, but also makes it cheaper. Dietary supplies from homegardens varies between 3% and 44% (Torquebiau 1992; Kumar and Nair 2004). They seldom meet entire food needs, but mostly function as supplementary sources, which may be exactly what is needed. This safety net role of a homegarden can potentially provide households with food plants outside of the main harvest season.

They have evolved under conditions of high population densities (Hoogerbrugge and Fresco 1993), yet they have received limited attention by research institutes and government agencies. Recently homegardens are considered important systems or nutritional programmes and research in India has shown that upscaling homegardens with a few components such as vegetables, fruits and spices increases year-round nutritional and food security (Singh et al. 2015). However, within urban food security issues, these 'traditional homegardens' have received very little attention.

Box 3.2 Important features that characterise homegardens (based on (Hoogerbrugge and Fresco 1993; Kumar and Nair 2004))

- Homegardens rarely supply the main source of food or income for the household, rather they form a form of supplementary production;
- They are flexible and constantly changing;
- They are extremely diverse, no two homegardens are the same;
- They serve multiple functions, not just food production, but also provision of fuel, medicine, herbs, aestethic purposes (ornamental), technical support (shade, timber etc), and soil conservation and organic waste management practices such as composting etc;
- Due to their highly dynamic nature, they function as 'continuity in production', which means that in one way or another they provide for the household all year long if soil and climate conditions allow and farmers manage their garden, and;
- In contrast to other agroforestry systems, homegardens include vegetable plots, herbal gardens and ornamentals.
- They can function as “incidental conservation sites”.

Since homegardens are characterised by structural complexity and multi-functionality which enables the provision of and different benefits to ecosystems and people (Galluzzi et al. 2010), they are generally difficult to study in a deductive way (Kumar and Nair 2004). The uniqueness of each homegarden makes it a challenge to design commonly accepted research procedures. Therefore many studies focus on inventory and increasingly more on diversity studies (Kumar and Nair 2004). Yet, considering this, homegardens play an important role in conservation, social networks, income and livelihoods, cultural spaces, and human nutrition (Galluzzi et al. 2010). However studies on specific nutritional contributions (and nutritional quality) are rare.

Urban homegardens however, are still poorly understood, their functions are similar to rural areas, however their prevalence is decreasing. Many people sell their valuable land or decide to build rental houses on their properties instead of keeping a garden. In the city people suffer from other nuisances also: pollution and theft are common issues. People are more likely to have day jobs and thus less time to manage and cultivate their garden. This may affect the compositions of the garden.

3.4 The potential of indigenous fruits

Traditional or indigenous species are sometimes referred to as neglected and underutilized species. All refer to non-commodity cultivated and wild species that are largely ignored by farmers and researchers. This can be caused by various factors such as agronomic, genetic, economic and cultural elements. However, these species can potentially contribute significantly to nutrition security and livelihoods, and are often well adapted to extreme weather events such as droughts. Consequently to their neglect and due to population migration traditional local knowledge of these species is disappearing. However, traditional food systems are maintained by people "*who retain knowledge of the land and food resources rooted in historical continuity within their region of residence*" (Johns et al. 2013).

There is a significant knowledge gap about indigenous fruits and their potential nutritional value. Very few species have been studied for their nutrient composition, something that has also been indicated by Stadlmayr (et al. 2013) in a literature review of ten selected indigenous fruit species from Sub-Sahara Africa (Table 3.1). The fruits are mainly analysed for macro-nutrients and minerals and rarely studied for their vitamin content, except for vitamin C (Stadlmayr et al. 2013). Furthermore, the data available shows that species nutrient values vary considerably among and within the different fruit species (Stadlmayr et al. 2013). Studying within species variation has also been indicated of importance by Leakey (2012) as these variations are important for cultivation purposes. Within species variation is further emphasized by data collected by Bangor University in a study on *Improved management and utilisation of Eastern Africa indigenous fruit trees*, which ran from 2007 to 2010 (also Table 3.1). Additionally, Stadlmayr et al. (2013) concluded that the lack of proper description of the biophysical and geographical environment of the species studied takes away the possibilities of using environmental data to explain within species differences.

Table 3.1 Overview of selected mineral and vitamin composition of 13 African indigenous fruit tree species (per 100 g) and recommended daily amount of micro-nutrients.

Species	Iron (mg)	Zinc (mg)	Beta-carotene (mg)	Vitamin C (mg)
Adansonia digitata L.*	6.2 ± 3.8	1.36 ± 0.79		273 ± 100
Balanites aegyptiaca*,**	13.8 ± 6.0* 46.76**	1.77* 2.85**		
Borassus aethiopum**	6.3 ± 2.4 (pulp) 14.3 ± 0.5 (seed)	0.3 ± 0.04 (pulp) 0.7 ± 0.03 (seed)	3.6 ± 0.9 (pulp) n.d.	14.6 ± 1.2 1.7 ± 0.9
Cordeauxia edulis**	4.26 ± 0.24 (pulp) 11.4 ± 0.8 (seed)	7.14 ± 2.43 (pulp) 3.3 ± 0.2 (seed)	n.d.	n.d.
Dacryodes edulis*	1.7 ± 1.8	0.47 ± 0.07		24.5
Irvingia gabonensis*				55.9 ± 5.9
Sclerocarya birrea*	3.4 ± 1.9	0.31 ± 0.10		11.9
Syzygium guineense*	7.9			167 ± 54
Tamarindus indica*	3.1 ± 1.6	3.1		15.5
Uapaca kirkiana*	11.3			16.8
Vitex doniana Sweet*	1.3 ± 1.1			5.2 ± 9.6
Vitex payos**	11.9 ± 2.0	3.3 ± 0.2	n.d.	0.26 ± 0.49
Ziziphus mauritiana*	0.8	0.03		2.8 - 13.6
Recommended daily amount	5 - 26	2.8 - 10	0.38 - 0.9	25 - 55

**Data from* (Stadlmayr et al. 2013). ***Data from Balanites aegyptica* (Okia 2010), *Borassus aethiopum* (Abbas 2010) *Cordeauxia edulis* (Abbas 2010) *and Vitex payos* (Kimondo 2010). *Recommended daily amount from* (FAOWHO 2002).

Studying nutritional composition of wild food plants is important because it can widen food choices, especially in times of food insecurity (Okia 2010). Promoting better nutrition for people requires knowledge about species as well as nutrition. Identifying current knowledge gaps as for example provided by Stadlmayr (2013) and understanding within species variation can provide insights into how urban malnutrition could be solved with the help of natural food sources.

About 3000 species of wild fruit trees can be found in Africa (Pye-Smith 2010), however these have hardly been studied to help tackle the growing global food challenges of quantity and quality. Increasing evidence shows that planting indigenous fruit trees on farms not only contributes to re-vegetation and on-farm biodiversity, but also improves farmers' livelihoods (Ruiz-Pérez et al. 2004; Schreckenberg et al. 2006; Teklehaimanot 2007; Leakey 2012). Case studies in southern Cameroon and Nigeria have shown that through selective breeding, the fruits of on-farm fruit trees are now 44-66% larger than in traditional forests (Leakey et al. 2004; Schreckenberg et al. 2006). This indicates that cultivation of nutrient-rich fruit producing tree species could form important opportunities for growing urban populations.

3.5 Discussion

Growing cities are dependent on distant food sources. However, food import brings transportation costs and this increases food prices. In a time where fuel prices are rising and simply unpredictable, these fluctuations can have significant influences on the diets of the urban poor. Planting fruit trees locally in cities asks for a substantially high investment, both financially as well as in labour (Tiffen 2006b). Purchasing the seedlings, dig planting pits and manage the young trees by watering them and protect them in order not to be eaten by goats or other animals asks for considerable dedication and patience on the farmer's part. Tenure- and ownership issues are an important factor for farmers to become involved in such practices, even though the returns on fresh fruits and vegetables can be considerably fruitful. One way of incentivising farmers to get involved in this type of production, while simultaneously form an environmental service of planting more trees, can be reached by implementing subsidy schemes.

Although exotic fruit trees such as *Mangifera indica* (mango) and *Persea americana* (avocado), are usually planted on homesteads and are well managed, the opposite is true for indigenous or wild species (Luckert 2002). This could be considered remarkable, since Agea (2010) found that, compared to conventionally planted crops, wild and semi-wild species are generally richer in sources of macro- and micro-nutrients, including beta-carotene, vitamin C, iron and zinc. This indicates that more attention should be paid to these wild species and not only during the pre-harvest months and in times of natural catastrophes, such as droughts and famine, but rather all year round (Agea 2010).

ICRAF's *Trees for Change* and *Quality Trees* programme has shown the value of domesticating indigenous fruit trees as an important strategy in alleviating poverty and to enable sustainable development (Leakey et al. 2010; Pye-Smith 2010). Exotic trees have often been improved, providing more yield than indigenous trees, but indigenous species can be improved also. Pye-Smith (2010) describes how local farmers from Cameroon now graft their own indigenous fruit trees, which has expanded their yield and increased their incomes by up to fivefold. Preference for exotic or indigenous fruit trees can also vary per season. In Botswana exotic fruits are consumed in the wet season, while indigenous fruits are harvested in the dry season (Legwaila et al. 2011). This shows that dietary diversity can increase and people can become more resilient to climate shifts when embracing both exotic as well as indigenous fruit types. A combination of these two can support nutrition, farmer's income and production security by providing year-round supply of important nutrients (Jamnadass et al. 2011).

Cities are complex systems. An element that should be taken into account when studying effects of urbanisation in Sub-Sahara Africa, is that it does not limit itself simply to rural-to-urban migration, but includes absorption of surrounding towns and villages into the urban spread. More complex even, and typical for Africa, is that migration often occurs seasonal and cyclical, thus establishing a strong connection between urban and rural linkages and creating multi-locational households (Tacoli 1998; Tiffen 2006a; Prain 2010; Prain and Lee-Smith 2010). However, to develop a proper policy strategy for urban food systems, data on urban agroforestry systems and diets are necessary. People's current access to and consumption of (indigenous) fresh fruits and vegetables should therefore be studied systematically (Stoian 2005; Kilchling et al. 2009; Nasi et al. 2011; Vliet et al. 2011).

More detailed research shows that urban food production is a complex system, as Legwegoh and Riley show in their comparison between two cities, Blantyre in Malawi and Gaborone in Botswana (Legwegoh and Riley 2014). Food insecurity in Gaborone was much higher than in Blantyre, 82% vs 51%, which is remarkable as Botswana is a more affluent country. They proceeded to analyse what could possibly explain these differences. First, they state that the physical environment plays a role. Blantyre is greener, has better rainfall and more favourable soils. Second, the political economy; Botswana's Gaborone serves the middle income households through supermarkets and the poor are forgotten. Whereas in Blantyre, the sector remains more informal creating better access to produce through markets, charities as well as a boost from government subsidies on fertilisers and other for food systems. And thirdly, the difference in food culture, vegetables and fish are embedded in Blantyre's cuisine whereas Gaborone dishes have much higher meat proportion (Legwegoh and Riley 2014).

Species diversity can be used as an indicator for potential field nutrition, even though higher species diversity does not necessarily mean higher nutritional diversity. Moreover, a farm can have fewer species but higher nutritional diversity. This shows how important it is to categorise on-farm species according to food group or nutritional components to determine nutritional levels (DeClerck et al. 2011). If indigenous fruit species are considered a viable option to increase nutrition security, there is a dire need for more and higher quality data. This can only be reached through sound and proper data sampling, handling and the choice as well as accuracy and precision of analytical methods (Stadlmayr et al. 2013).

3.6 Conclusion

Strategies to reach urban nutrition security should combine different approaches and disciplines (IFPRI 2016). In this review, it becomes clear that the key to a nutritious diet is to have access to a variety of foods. Agro-biodiverse production of nutrient rich food plants in and around cities can form part of the solution. However very little rigorous research has been conducted on this topic and how it can contribute to a healthy sustainable urban community (Powell et al. 2011; Johns et al. 2013). More importantly there is a need to design proper tools that combine the different fields of agro-biodiversity and nutrition in the urban landscape. Research gaps that can be identified are:

1. Assessment of the nutritional values of urban produced food items.
2. Assessment of food group based diversity in the different urban vegetation systems discussed.
3. Systematic monitoring and evaluation of urban diets to determine deficiencies within urban communities.
4. Develop proper tools to measure and link nutrition deficiencies with urban food systems.

- Determine the role indigenous foods have and could have in solving urban malnutrition and food insecurity.

5. Determine the barriers in healthy urban food production and how these systems can be improved.

4 RICHNESS AND DIVERSITY IN URBAN UGANDA: AN INVENTORY OF KAMPALA'S HOMEGARDENS

Abstract

Urban homegardens provide multifunctional biodiversity hotspots in an urbanising world. Kampala is one of the fastest growing cities in Sub-Saharan Africa, and urban homegardens are under threat. However, their true potential is still poorly understood. The aims of this study were: 1) to determine which factors predict species composition, 2) to classify use categories of homegardens, and 3) to establish whether homegardens provide *circa situ* conservation purposes for underutilised and indigenous plant species. This paper presents a full inventory of 74 homegardens from inner-, outer- and peri-urban Kampala, which were visited between February and April 2015. For each plant species the sources and uses were recorded. The total number of plants found was 270, of which 248 were considered useful. The mean species richness was 25.50, Shannon Wiener index 2.37, Evenness 0.78 and Density 390, with 70 edible species and 101 medicinal plant species. Stepwise regression indicated plot size as a strong predictor of garden richness, as well as length of time farming, hiring of labour and having received training and benefits. Urban gardens can provide the opportunity to incorporate biodiversity in the urban landscape while forming more sustainable cities. However, this requires transdisciplinary collaborations between city planners, ecologists, human nutritionists and ethnobotanists.

Key words: Floristic diversity, ethnobotany, urban biodiversity, Shannon index, Species composition, Vegetation structure

4.1 Introduction

Urban homegardens are hidden heroes in an urbanising world. They are severely under studied and thus poorly understood, yet provide many different benefits (Bernholt et al. 2009; Galluzzi et al. 2010; Thompson et al. 2010). The little hotspots of high biodiversity function as “incidental” conservation sites (WinklerPrins and Oliveira 2011; Lwasa et al. 2014) and they form an important tool in mitigating climate change (Lwasa et al. 2015). However, due to high urbanisation rates (UN 2012; The World Bank 2015) the urban landscape is changing rapidly (Vermeiren et al. 2012) and in a city where the rise of unplanned settlements and exponential building ensues, pressures on natural vegetation are high (Alberti 2005; Cohen 2006; McKinney 2008; The World Bank 2015).

Homegardens represent some of the oldest land management practices contrived by humans and are even considered the "epitome of sustainability" by some (Torquebiau 1992; Doolittle 2004; Kumar and Nair 2004). They are “engines of economic and social development” where species diversity is highly dynamic (Kumar and Nair 2004), influenced by socio-economic and agroecological factors (Kehlenbeck and Maass 2004; Bernholt et al. 2009). Homegardens provide food and medicine, they enhance social networks and services, provide income, livelihoods and cultural space (Galluzzi et al. 2010). In other words, their structural complexity and multi-functionality enables the provision of many different benefits (Galluzzi et al. 2010; Wilhelm and Smith 2017).

Despite being recognised as biodiversity hotspots and critical for their role in conservation of biodiversity, most policy makers still ignore their importance. Consequently, homegardens are changing and even disappearing (Kumar and Nair 2004). Urban homegardens have received even less attention (Drescher et al. 2006; Bernholt et al. 2009; Panyadee et al. 2016), as most knowledge of homegardens is based on studies conducted in rural areas (e.g. (Kumar and Nair 2004; Kehlenbeck et al. 2007; Rahman et al. 2013)).

Although urban biodiversity is gaining more recognition in the literature (McPhearson et al. 2016; Wilhelm and Smith 2017), the particular role and contributions of homegardens to household use remains unclear. This is partly due to the lack of transdisciplinary approaches, where urban planners, ecologists and ethnobotanists collaborate in urban projects to create sustainable cities (Lwasa et al. 2014). Urban homegardens have been considered rural remnants, for which there is no place in the urban setting. Understanding the true value of these homegardens may challenge their perceived sustainability in an urban world. There is, however, an increased interest in urban food production (Poulsen et al. 2015; Warren et al. 2015), which may include homegardens, depending on which definition you consider (Drescher et al. 2006).

In Uganda, urban agriculture is as old as cities themselves (Maxwell and Zziwa 1992). It is often defined as a productive land use system for staple foods and fresh fruits and vegetables (Maxwell et al. 1998; David et al. 2010; Vermeiren et al. 2013). The term has become an umbrella under which several urban production systems can be found (Drescher et al. 2006). They include allotment gardens (plots away from the homes), community gardens as well as backyard farming systems.

In this study, we focus on this last system. We adopt the term homegarden for gardens connected to the homestead only. The main reason for this is that since these gardens are located so close to the house, they are better protected, have more secure tenureship and are therefore hypothesised to have higher species richness.

Few studies focus on urban homegardens as a multifunctional use system, that preserves biodiversity, and that documents an inventory of all species present, such as medicinal herbs, while also providing food plant data, ornamental plants and technical uses (Bernholt et al. 2009; Thompson et al. 2010).

Kampala is one of the fastest growing cities in Sub-Saharan Africa and currently home to about 1.9 million (CIA 2016). This has caused the city to increase built-up space by replacing urban vegetation (Vermeiren et al. 2012). Simultaneously, increase in heavy rainfall due to climate change causes even more damage (Baastel Consortium 2015). This combination of increased rainfall intensity and clearance of vegetation on the city's hills causes severe flooding. This makes it even more urgent to preserve and protect the green spaces that remain such as homegardens. Urban homegardens can potentially provide *circa situm* (where preservation of species occurs in locations where natural vegetation has been lost or modified such as in agricultural areas and cities (Pinard et al. 2014) conservation opportunities.

Beyond conservation of biodiversity urban homegardens provide important ecosystem services. They have the potential to improve human wellbeing by providing basic needs such as food and medicine. There is a need to understand the role of urban gardens by conducting an extensive quantified inventory of both cultivated and non-cultivated species in urban gardens and record their specific uses. The main objective of this paper is therefore to assess plant composition (species richness and diversity) in selected homegardens of urban and peri-urban Kampala. More specifically it answers the following research questions:

- Which socio-economic and geographical factors determine species composition?
- Which use categories are derived from homegardens?
- How do homegardens provide *circa situ* conservation purposes for underutilized and indigenous species?

4.2 Materials and methods

4.2.1 Study area

Fieldwork for this study took place in Kampala, Uganda, between February and August 2015 (0°19'N, 32°35'E) (Figure 1). The city is situated in the Lake Victoria Crescent agro-ecological zone, it has an annual bimodal rainfall pattern which averages between 1750 and 2000 mm per year and the average temperature is 23°C (The World Bank 2015). The larger region has medium to highly fertile soils and is subject to intensive banana and coffee production systems. However other crops are gaining popularity, such as sweet potatoes and maize (Mwebaze 2006). The potential vegetation type can be classified as *Lake Victoria drier peripheral semi-green Guinea-Congolian rain forest* (Kindt et al. 2011).

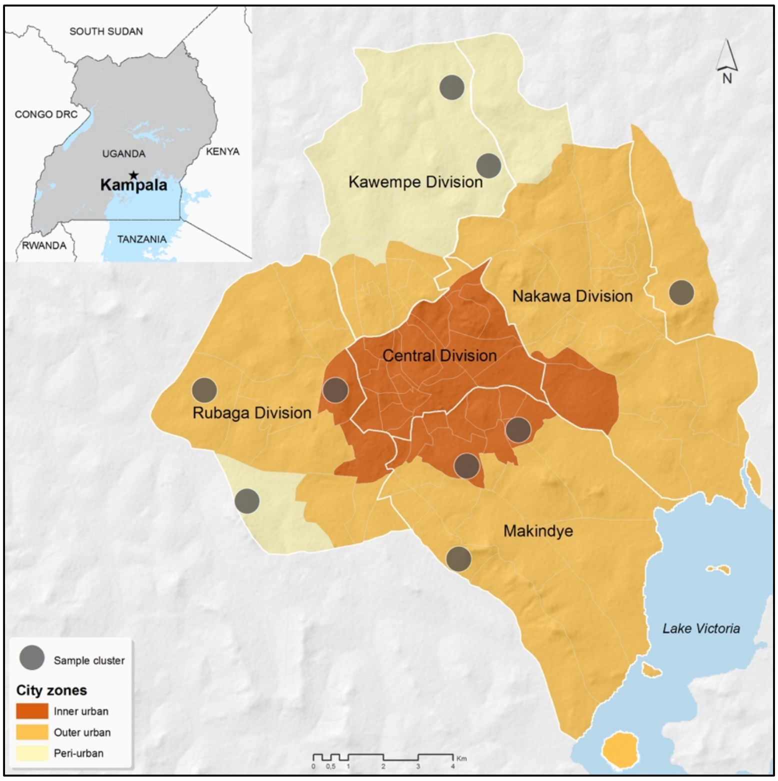

Figure 4.1 Map of Kampala, Uganda with inner-, outer-, and peri-urban areas indicated. The nine cluster sampling sites are indicated with the grey dots (source: adapted from (Mollee et al. 2017)).

4.2.2 Study design

This study included 74 households. The target study population for this study was low-income households with homegardens. Kampala's physical development plan was used to identify three residential area typologies, inner-, outer-, and peri-urban (KCCA 2012) (figure 4.1). In each typology three parishes were selected based on residential characteristics, homegarden prevalence, population density, location and proximity to the city. These parishes included *Namirembe, Kabalagala* and *Nsambya/Lukuli* with an average population density of 301 people per hectare in inner Kampala; *Busega, Kireka* and *Luwafu* with an average population density of 115 people per hectare in outer Kampala; and *Kyanja, Kikaya,* and *Mutundwe* were included from the peri-urban urban Kampala with an average of 60 people per hectare (UBOS 2014). Through purposive selection, seven to ten households were included from each parish. The aims of the study were explained to the respondent and consent was sought. Upon agreement, the households were visited on three occasions.

4.2.3 Data collection and data handling

Paper-based data collection was conducted with the use of field assistants, so there was more space for the interviewer to ask additional questions and approach the interview in a more unstructured way to keep the participant interested. The bilingual field assistants were trained in conducting the pre-tested questionnaires prior to the visits. Most interviews were conducted in the local language Luganda, others in English.

4.2.4 Agrobiodiversity and livestock

All homegardens were connected to the house, and considered part of the homestead (Drescher et al. 2006). A note was made when people farmed additional plots outside the homestead (allotments), but plants on those plots were not included in the inventory. Complete botanical inventories of the homegardens were conducted by ethnobotanists, and samples that could not be identified in the field were taken to the herbarium at Makerere University for later identification. All plants were included in the inventory, and for each plant species found in the garden, the respondent was asked about their usage, parts used and source (e.g. bought, gift or wild grown). All plants were coded for their primary use and other uses: *Food* (including stimulants and condiments), *Medicine*, *Ornamental* and *Technical* (non-consumable, including livestock fodder, fuel, timber, boundary markers and living fence), or *no use*. This last group of 'weeds', were later excluded for further analyses. Scientific names, geographical origins and potential uses were later determined using field guides and databases. The nomenclature system as provided by The Plantlist (**http://www.theplantlist.org/** 2013) was followed.

In addition, the number of livestock and their use was documented. GPS coordinates were taken of the location, and plot sizes were estimated to control for farm size. Plot sizes used for garden calculations excluded all built structures.

After collection, all food plant species were categorised into one of six common food groups: 1) Starchy staples, cereals and plantains, 2) Vegetables, 3) Fruits, 5) Legumes, and 6) Condiments, herbs, spices and sweets. For some cultivated plant species, botanical categorisation was based on different varieties that function as two different food groups (e.g. *Brassica oleracea* L. (kale (or 'Sukuma wiki') and cabbage) *Capsicum annuum* L. (chilli pepper and bell pepper) and *Solanum aethiopicum* L. (Gilo group, an African eggplant ('Ntula'), and Shum group, a leafy green vegetable ('Nakati'))).

In addition, a distinction was made for two types of *Musa* spp*,* sweet bananas and plantains, since both were abundant in the field sites, yet fill different roles in dietary contribution, as a fruit and a starchy staple respectively.

4.2.5 Socioeconomic data

A structured household questionnaire was conducted to collate socio-economic data, such as number of household members, geographical origin, income sources and assets. The wealth index was calculated through a relative poverty calibration using a multidimensional poverty index tool based on multiple poverty indicators such as household assets, housing structures and income sources (Henry et al. 2003).

4.2.6 Data Analysis

Data analysis was conducted in SPSS (version 22) and R using packages vegan (Oksanen et al. 2016; R Core Team 2016). For each data set, species richness and abundance data were used to calculate Shannon Wiener diversity indices (*H'*) and Shannon evenness indices (*J'*). Since the homegardens differ in size, abundance was transformed to individual density per 1,000 m^2. These abundance numbers were then used for all further analyses.

To check for differences between the three urban areas, Chi-square tests were conducted for proportion variables (%). For other units of variables, the Shapiro-Wilk's test were used to test for normal distribution. Followed by parametric tests (*t*-tests or

ANOVAs and post-hoc Tukey's) test for normal distributed variables or non-parametric tests (Kruskal-Wallis and Wilcoxon-Mann-Whitney's *U* tests).

The summed dominance ratio (SDR) was calculated to describe and compare the use category composition of the gardens in the three urban areas. The importance of the use categories were calculated by categorising the species into food groups and calculate their relative frequency and relative density within the respective areas (McCune and Grace 2002).

Spearman's correlation coefficient to check for association between farm size, species richness, species diversity (Shannon) and species evenness. A stepwise multiple regression analysis (GLM) was conducted to test determinants for species richness (Kindt and Coe 2005; Zuur et al. 2009).

4.3 Results

4.3.1 Socio-economic characteristics

Most respondents were female (77%), and 82% were the main gardeners in the household (Table 4.1). Their ages ranged between 18 and 89 years old, with a median age of 40. Overall, 88% of the respondents had finished lower primary school. Half of the respondents (50%) were married or cohabiting. At least twelve ethnic groups were included in the survey, however the dominant ethnic group in the sample were Baganda (81%). Household sizes were similar in all three areas (mean = 6.68), however they ranged between one to fifteen members. Food expenditure during the week before the interview was similar in all three areas, which showed 45% of the households reported spending equal to or less than the poverty line income on food (40,000 UGSh or 2 US$ per day) for the entire household. Relative wealth status between the three areas indicated an above average majority in inner Kampala (42%), while poorer households were more dominant in outer- and peri-urban areas, 36% and 40% respectively. Most households had informal businesses as their main income source (74%), 8% were dependent on relatives or friends outside the households. Respondents with an urban background were mainly found in inner Kampala (33%

Table 4.1 Profiles of 74 gardens and gardeners in three urban areas of Kampala (Uganda), 2015.

Variables and classes	**Inner Urban** (n = 24)	**Outer Urban** (n = 25)	**Peri Urban** (n = 25)	**Overall** (n = 74)	**Test Statistics**
Mean population density (people/ha)	301	115	60	*na*	*na*
Median garden size (± s.d. (range)) (m2)	407 (117 - 734)	540 (53 - 1477)	523 (55 - 2273)	510 (53-2273)	χ^2= 1.194 p = 0.551
Has received UA training (%)	8	4	8	7	*ns*
Has received UA benefits (tools, seeds etc) (%)	4	0	4	3	*ns*
Has hired labour (%)	17	12	32	20	*ns*
Experiences challenges (%)	79	88	76	81	*ns*
Theft	33	32	40	35	*ns*
Foraging by animals	21[b]	60[a]	12[b]	31	χ^2 = 15.186 p < 0 .001***
Drought	13[b]	56[a]	20[b]	30	χ^2 = 12.802 p = 0.002**
Pests/diseases	38	52	44	45	*ns*
Median number of challenges (range)	1.5 (0-4)	2.0 (0-4)	2.0 (0-4)	2.0 (0-4)	*ns*
Median TLU (range)	0.00 (0 - 2.10)	0.06 (0 - 3.50)	0.03 (0 - 3.07)	0.03 (0 – 3.50)	χ^2= 3.025 p = 0.220
Has livestock (%)	42	60	56	53	*Ns*
Years farming <10 years (%)	50	48	64	53	*Ns*
Origin respondent urban (%)	33[a]	12[ab]	4[b]	16	χ^2=8.249 p = 0.016*
Origin respondent rural (%)	54	76	80	70	*Ns*
Time residence >10 years (%)	71[ab]	84[a]	52[b]	69	χ^2=6.036 p = 0.049*
Time residence <5 years (%)	17	4	12	11	*ns*
Main Income source informal business (%)	67	76	80	74	*ns*
Food expenditure < 40k (%)	50	46	40	45	*ns*
Marital status cohabiting or married (%)	38	52	60	50	*ns*
Main Ethnicity in hh is Baganda (%)	79	84	80	81	*ns*
Mean household size (± s.d. and range)	6.25 ± 3.57 (1-15)	7.04 ± 2.69 (2 – 13)	6.72 ± 2.67 (3 - 13)	6.68 ± 2.97 (1-15)	F = 0.430 p = 0.652
Respondent is female (%)	75	80	76	77	*ns*
Age Median (range)	43 (18 - 89)	46 (18-80)	33 (20 - 82)	40 (18-89)	χ^2= 2.031 p = 0.362
Age<40 (%)	46	42	60	49	*ns*
Education > upper primary (%)	58	44	56	53	*ns*
Education > lower primary (%)	83	88	92	88	*ns*
Wealth status highest tercile (%)	42	32	24	33	*ns*
Garden responsibility (%)					
Respondent	75	88	88	82	*ns*
Someone else	25	12	13	16	*ns*

Different letters after means indicate significant difference at p <0.005 (one-way ANOVA followed by Post-hoc Tukey test for parametric count data, Kruskall-Wallis for non-parametric data and χ^2 with Bonferroni for proportion data). ns = non-significant.

versus 4%, p = 0.016), however the overall majority of the respondents had a rural background (70%). Respondents in outer Kampala, had been in their current home for longer periods (>10 years) than in peri urban areas (84% versus 52%, p = 0.049), however overall, most respondents have been living in their home for more than 10 years (69%).

4.3.2 Homegarden composition

A total of 270 plant species were initially identified, of which 248 species from 69 families were considered useful and included in the final analyses (Table 4.5 in Supplement). The most abundant phenotypes were herbaceous species (136), followed by 55 tree species, 52 shrubs, and five grasses. This means that at 92% of the species found in the gardens can be considered useful. Most species were used as medicinal plants (41%), followed by foods (28%) then technical (21%), and ornamental (10%). Eight plant species remained unidentified of which four ornamental and four medicinal species. The proportion of native plant species was 43%, exotic species 49% and for 8% it remained unclear however most of them are considered naturalised.

Mean size of cultivable areas of the homegardens (total plot size minus built structures) was 510 m^2 (ranging from 53 to 2,273 m^2) (Table 4.1). No significant differences in garden size were found between the three urban areas. Only 7% ever received training in urban agriculture practices, with less than half of these (3%) mentioning if they ever received urban agriculture related benefits such as seeds or tools. 20% of the respondents sometimes hires labourers to help with the garden. Most respondents experience challenges (81%). The main challenge reported are pests and diseases, by 45% of all households, followed by theft (35%). A significant difference was found between the outer urban area and the other two areas for foraging by animals (χ^2 = 15.186; p = 0.001) and drought (χ^2 = 12.802; p = 0.002). Most the respondents have been farming in the garden between four to ten years (32%), although the length of time farming varies greatly between the respondents, from <1 year (7%) to >40 years (15%).

All homegardens inventoried can be considered non-commercial and for private use only. In some cases, for example when an avocado or mango tree is fruiting, gardeners would share or sell some of their harvest. However, this was only when harvest was too much for home consumption.

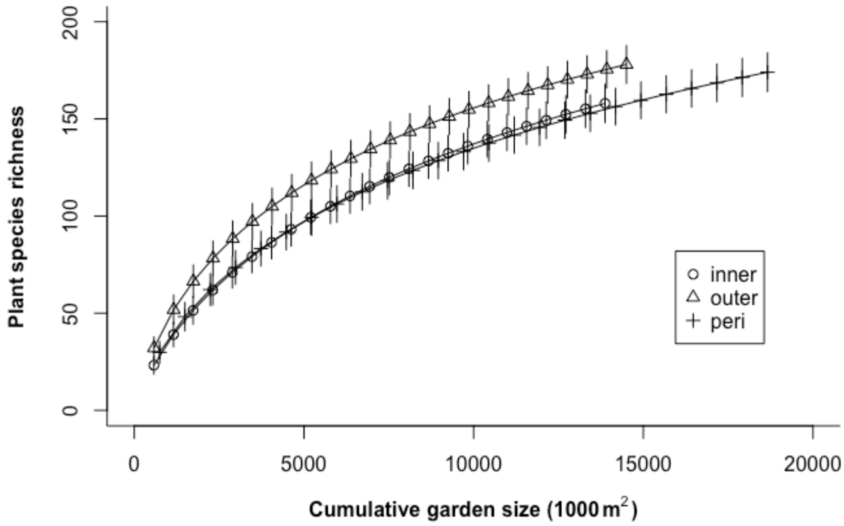

Figure 4.2 Species accumulation curves using observed richness for 74 gardens in three urban areas in Kampala (Uganda), 2015

4.3.3 Agrobiodiversity of homegardens

Of the total of 248 useful plant species inventoried, 70 species were food plant species and covered 32 botanical families. The highest number of food plants were fruit species (24) of which three were indigenous species (Table 4.2). Not all food species were ready for harvest during the time of the inventory.

Plantains (*Musa* spp) dominated the field sites as they were observed in more than 93% of the surveyed gardens. Avocado trees (*Persea Americana* Mill.) were the most common fruit trees as they were found in 89% of the gardens followed by Papaya (*Carica papaya* L.) (81%) and Mango (*Mangifera indica* L.) (75%). *Amaranthus dubius* Mart. Ex. Thell. (locally known as 'doodo', a dark green leafy vegetable) was found in about 73% of the surveyed gardens. The Green Uganda pea eggplant (*Solanum anguivi* Lam.), locally known as 'Katunkuma' was the most frequent indigenous food plant and present in 70% of the gardens.

Table 4.2 Total number of plant species per use category and according to origin found in 74 gardens in Kampala (Uganda) 2015.

Use category	**Indigenous species**	**Exotic species**	**Total species number**[a]
Food	11	57	70
Starchy staple, cereal and plantain	*0*	*9*	*9*
Vegetable	*3*	*15*	*20*
Fruit	*3*	*21*	*24*
Legumes, nuts and seeds	*2*	*1*	*4*
Condiments, herbs, spices and sweets	*3*	*11*	*15*
Medicinal	60	29	101
Technical	29	24	53
Ornamental	7	12	24

[a]*Total number includes species for which origin is unclear.*

The summed dominance ratio indicated some differences between the composition of the gardens for food group plants between the three urban areas (Figure 4.3). The relative contribution of food plants to the composition of the gardens was lowest in peri-urban areas, where medicinal species were more dominant compared to the two other areas. However, the outer urban gardens contained relatively more staple food plants, 23% of total garden food plants, than in inner urban areas (16%). While in inner urban areas the gardens contained relatively much more vegetable plant species compared to peri-urban areas (32% vs 18%).

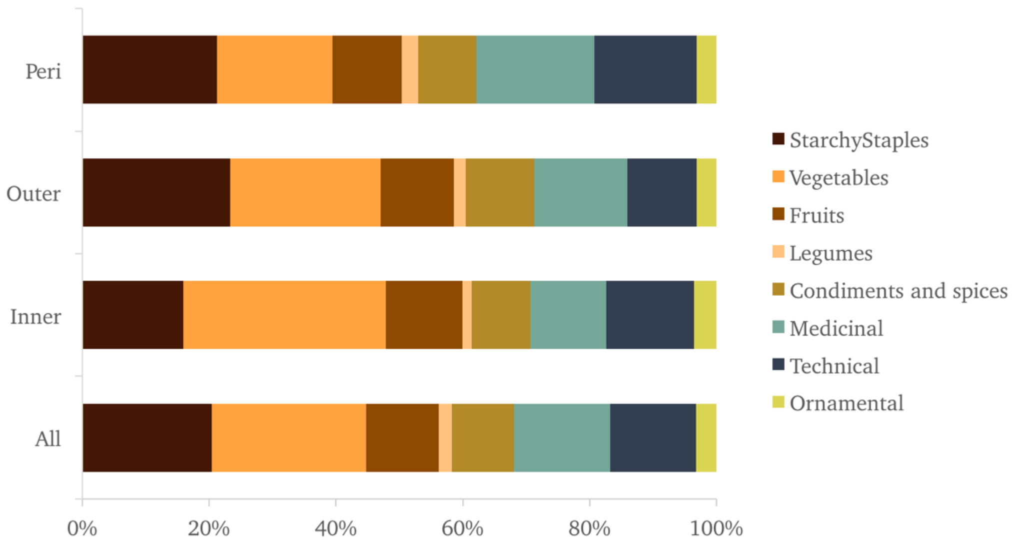

Figure 4.3 Summed dominance ratio (SDR) of plant species grouped use groups in all three urban areas and all combined in Kampala, Uganda in 2015.

4.3.4 Diversity within Kampala

Garden richness did not differ significantly between the three urban areas. However, it did vary between households due to different plot sizes as Pearson's product-moment correlation indicated a significant positive association between garden size and species richness ($r = 0.507$; $p < 0.001$; Figure 4.4 and Supplement 2). Garden richness ranged between 11 and 65 due to different species in each garden with a median of 25.5 (Table 4.3).

Garden diversity (Shannon) was higher in outer urban areas than in inner urban areas ($p = 0.011$), and an overall Shannon index of 2.37, yet Evenness (0.78) did not show significant differences between the sites.

The proportion of woody species was larger in peri-urban areas than in inner urban areas 50% versus 42% respectively ($\chi^2 = 6.701$, $p = 0.035$). Of all tree species, 73% were fruit trees species, of which 68% consisted of exotic fruit tree species.

The proportion of edible species in the gardens varied vastly across gardens, between 27% and 94% (mean was 59%), of which the proportion of exotic species was 85%. Of all plant species, the indigenous proportion ranged between 0% and 57.14% (mean was 32.46%).

Table 4.3 Mean values (ranges in brackets) of food plant species diversity parameters in three urban areas in Kampala (Uganda), 2015.

Parameter	**Inner Urban**	**Outer Urban**	**Peri Urban**	**Overall**	**Test Statistics**
	($n = 24$)	($n = 25$)	($n = 25$)	($n = 74$)	
Median richness (range)	18.00 (11 – 49)	30.00 (11-65)	28.00 (8 – 63)	25.50 (8-65)	$\chi^2 = 5.312$ $p = 0.070$
Mean richness	23.21 ± 11.22	32.08 ± 15.45	29.84 ± 14.49	28.45 ± 14.19	-
Median density (range)	390 (36 – 3410)	252 (59 – 3879)	461 (86 - 2093)	390 (36 - 3879)	$\chi^2 = 1.493$ $p = 0.474$
Shannon (range)	2.16[b] (0.50 – 3.28)	2.65[a] (1.5 – 3.78)	2.29[ab] (0.85 – 3.36)	2.37 (0.50 – 3.78)	F = 4.799 $p = 0.011$
Evenness (range)	0.76 (0.18 – 0.95)	0.83 (0.38 – 0.92)	0.72 (0.24 – 0.93)	0.78 (0.18 – 0.95)	$\chi^2 = 4.142$ $p = 0.126$

Different letters after means indicate significant difference at p <0.05 (one-way ANOVA followed by Post-hoc Tukey test for parametric count data, Kruskall-Wallis for non-parametric data).

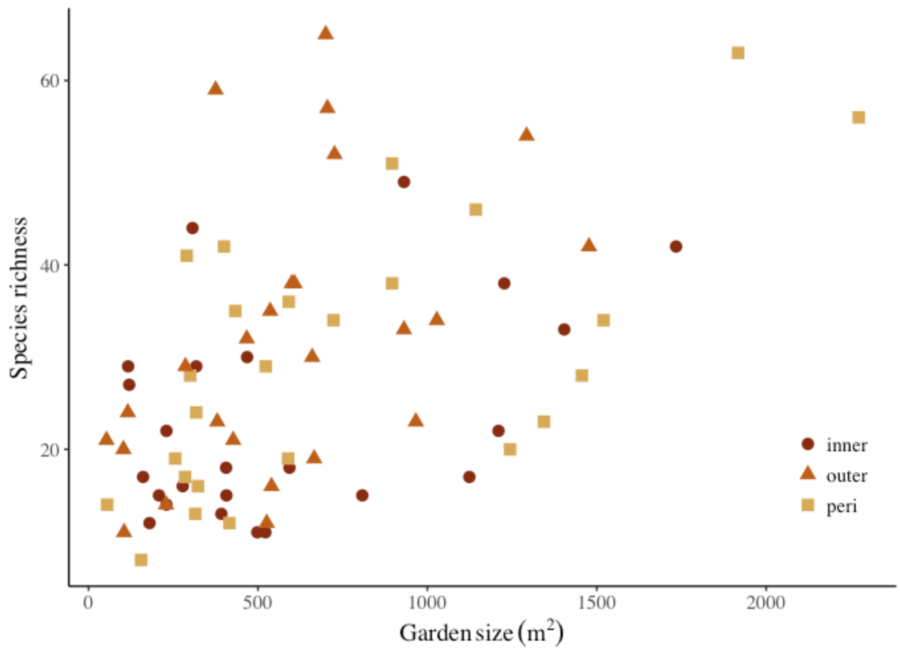

Figure 4.4 Relation between plant species richness and garden size in the three urban areas (inner, outer and peri) in Kampala (Uganda), 2015.

4.3.5 Determinants of richness, density and diversity

A stepwise multiple regression analysis also confirmed that garden size determined species richness (Table 4.4). Other variables that predicted species richness were a longer time of farming (p = 0.006), has received benefits (p = 0.005) and has hired labour (p = 0.019).

Table 4.4 Results of stepwise multiple regression analyses for different parameters of plant species richness in 69 gardens of Kampala (Uganda), 2015.

Independent variables	Estimate	*Standard error*	*p*-value
Garden size (m^2)	0.010443	0.003469	0.004**
Gardener is female (0 = no; 1=yes)	-6.012537	3.137996	0.060
Background is rural (0 = no; 1=yes)	-4.214987	2.752732	0.131
Has hired labour (0 = no; 1=yes)	9.686102	4.017548	0.019*
Education level > upper primary level	-4.628030	2.418288	0.061
Has livestock (0 = no; 1=yes)	3.552131	2.551452	0.169
Has been farming > 10 years (0 = no; 1=yes)	-7.282223	2.570809	0.006**
Has received benefits (0 = no; 1=yes)	-16.328092	5.560802	0.005 **
Challenges (0 = no; 1=yes)	-6.255792	2.735684	0.026 *
Constant	33.492595	5.454832	$P < 0.001$

Five households were excluded from this analysis due to missing values in the independent variables.

4.4 Discussion

4.4.1 Garden compositions

The surveyed gardens were highly variable in size, species richness and overall composition. Compared to previous literature, the overall species richness of 270 documented is much higher than reported in other urban studies. Even after correcting for the number of gardens included, and the exclusion of non-useful 'weeds', the results presented figures much higher than those by Bernholt et al. (2009) who found on average 14 species per garden in Niamey (Niger) and by Thompson et al. (2010) who found 'only' 4.4 in Khartoum (Sudan).

Several reasons can be given to explain the difference between the average of 25.5 species per garden found in this study and those of Bernholt et al. (2009) and Thompson et al. (2010). Firstly, the difference in agroclimatic zone can be an explanatory factor. The aforementioned studies conducted their research in significantly dryer regions, while Kampala with its tropical rainforest climate has plenty of rainfall and fertile soils. When comparing garden richness with another urban study in tropical Brazil however, the findings are more similar (although an exact comparison is difficult to make since data was presented categorically) where 58% of the gardens had more than 20 species (Akinnifesi et al. 2009).

As a second reason, the research design may differ. Typically, in these types of studies, a gardener (or farmer) is asked which species they consider useful on a garden or farm walk. This approach is accepted and relatively quick, at least compared to the approach used in this study. This risk with the former approach is, however, that many minor species may be ignored and forgotten. The approach used in this study avoided that issue by initially conducting a full inventory and followed this by asking each gardener about their uses.

A third explanation can be that, in fact, the type of urban gardens studied vary between studies. Bernholt et al. (2009) clearly state that their choice of including, what Drescher et al. (2006) defines as allotment gardens, was a pragmatic choice. Land scarcity and the need be close to (irrigation) water were important decision criteria for farmers in arid and semi-arid regions, and therefore for the researchers also. In the case of

Kampala, it becomes clear that land scarcity affects homegarden prevalence, as it is financially attractive to sell off property or built structures as rentals for income.

When comparing these findings with homegardens in rural areas, for example in Ecuador where 32 useful plant species were found in Amazonian homegardens, they appear more authentic (Caballero-Serrano et al. 2016). Similarly, Goenster et al. (2011) found 22 woody species per homegarden in Central Sudan, thus the species richness reported in this study mimics the richness of (tropical) rural homegardens.

4.4.2 Socio-economic determinants and geographical factors

The garden plot size was the main determining factor in plant species richness in this study, similar to Bernholt et al. (2009). Considering that the *length of time farming*, *benefits* and *hired labour* were all factors that contributed to a higher likelihood of species richness, it indicated that determinants of garden plant richness was dependent on a more common typology of active potentially entrepreneurial gardeners. However, a cluster analysis should provide more insight into this.

Overall, there weren't many significant differences between the three areas. Two factors could potentially explain this. Firstly, since the study design was specifically aimed at homegardens it excluded other allotment plots, and therefore commercial farming enterprises that were present in other studies (i.e. Vermeiren et al. 2013). They are characterised by larger plots and predominantly found in the urban fringe. Secondly, what was considered peri-urban in this study, might be considered urban by some definitions as the definition of peri-urban remains a grey area (Iaquinta and Drescher 2000; Baumgartner and Belevi 2001).

4.4.3 Uses

The findings in this study confirm the multifunctional nature of homegardens with 92% of the species found had use value (Kumar and Nair 2004; Galluzzi et al. 2010; WinklerPrins and Oliveira 2011). Most species had more than one use (Supplement 1,

Table 4.5), and thus fit into more than one category. However, for ease of analysis purposes only main use were considered in the analyses.

Most species found in the gardens were herbs used for medicinal purposes, a largely unexplored field in the urban context and generally thought to be suffering from erosion of traditional knowledge (Vandebroek et al. 2011; Vandebroek and Balick 2012). Further exploration of this finding is currently conducted.

It is hard to compare the 70 edible plant species in this study with previous findings in the region as most studies report on common crops species only and ignore wild and underutilised food plants. For example, *Amaranthus dubius* Mart. Ex. Thell. (a dark green, leafy vegetable) was one of the most common species and consumed by almost all households, yet was considered "wild" in most gardens as no active cultivation occurred.

4.4.4 Potential for circa situm conservation and promotion of underutilised species

Even though 43% of the species documented in the overall inventory is considered indigenous, the actual proportion of indigenous plant species in homegardens was lower (32%). Based on these findings, the homegardens included in this study function moderately as *circa situm* conservation sites. However, none of the plant species inventoried in the gardens is in a critical state of endangerment according to the IUCN red list.

The high number of medicinal plants found in the gardens provides the opportunity for people to access herbal medicine, on which most Ugandans depend as their source of primary health care (WHO 2002; Tugume et al. 2016). This not only provides free access to simple herbal remedies, but it also preserves traditional knowledge systems.

Furthermore, there is potential to conserve underutilised edible species. Many leafy, green vegetables as well as fruit species such as *Vangueria apiculata* K. Schum have been ignored in urban programmes, however they are highly appreciated by urban gardeners.

4.5 Conclusion

This study provided a detailed overview of a selection of Kampala's homegardens. The homegardens consist of high species richness and diversity and provide people with a multitude of uses, far beyond common edible crops. From the 270 plant species identified in the gardens, 248 were considered useful by the gardeners. Furthermore, the 70 edible plant species reported here extent previous report for Kampala.

This study is the first that we know of that has studied plant diversity and use in Kampala in this much detail. It adds to the body of knowledge of a city well studied for its role in urban agriculture literature. The importance of urban homegardens for both ecological functions as well as socio-economical provisioning services can no longer be ignored. To incorporate biodiversity and green structures in urban landscape designs to create holistic sustainable cities is important. However, this requires transdisciplinary collaborations between city planners, ecologists, human nutritionists and ethnobotanists.

Supplement 1: Table 4.5 Wild and cultivated food plant species, and their uses in 74 gardens in Kampala (Uganda) in 2015, sorted by their main use category and frequency.

Botanical family	Botanical name	Common name	Local name (Luganda)	Growth form	Origin[(a)]	Frequency	Abundance (count)	Proportion of households (%)	Main use[(b)]	Other uses[(b)]	Edible part(s)	Food type	IUCN status[(c)]
FOODS													
Musaceae	*Musa* spp (matooke)	Banana - matooke	Matooke	Herb	E	69	912	93.24	F	T	Fruit	Starchy staple	LC
Lauraceae	*Persea americana* Mill.	Avocado	Ovakedo	Tree	E	66	320	89.19	F	M, T	Fruit	Fruit	-
Caricaceae	*Carica papaya* L.	Papaya	Mupaapaali	Tree	E	60	193	81.08	F	M, T	Fruit	Fruit	DD
Anacardiaceae	*Mangifera indica* L.	Mango	Muyembe	Tree	E	55	131	74.32	F	M, T	Fruit	Fruit	DD
Amaranthaceae	*Amaranthus dubius* Mart. ex Thell.	Amaranthus spinach	Doodo	Herb	E	54	3179	72.97	F	M, T	Leaves, stem	Vegetable	-
Solanaceae	*Solanum anguivi* Lam.	Green Uganda Pea Eggplant	Katunkuma	Shrub	I	52	287	70.27	F	M, T	Fruit	Vegetable	-
Araceae	*Xanthosoma sagittifolium* (L.) Schott	Cocoyams, upland yam, arrow root	Kakupa	Herb	E	51	1549	68.92	F	T, M	Tubers	Starchy staple	-
Moraceae	*Artocarpus heterophyllus* Lam.	Jackfruit	Mufene	Tree	E	50	235	67.57	F	M, T	Fruit	Fruit	-
Poaceae	*Saccharum officinarum* L.	Sugarcane	Kikajjo	Grass	E	47	274	63.51	F	T	Stem	Sweet	-
Cucurbitaceae	*Cucurbita maxima* Duchesne	Pumpkin	Nsujju	Herb	E	43	195	58.11	F	M, T	Fruit, leaves	Vegetable	-
Musaceae	*Musa* spp (sweet)	Banana - Sweet	Banana	Herb	E	42	204	56.76	F	T	Fruit	Fruit	LC
Lamiaceae	*Ocimum gratissimum* L.	Wild Basil	Mujaaja	Herb	I	40	368	54.05	F	M	Leaves, stem	Herb/Spice	-
Euphorbiaceae	*Manihot esculenta* Crantz	Cassava	Mawogo	Shrub	E	38	1114	51.35	F	T	Tubers	Starchy staple	-
Myrtaceae	*Psidium guajava* L.	Guava	Mupeera	Tree	E	36	88	48.65	F	M, T	Fruit	Fruit	-
Solanaceae	*Solanum lycopersicum* L.	Tomato	Nyaanya, Obunyaanya	Herb	E	30	199	40.54	F	M	Fruit	Vegetable	-

Botanical family	Botanical name	Common name	Local name (Luganda)	Growth form	Origin[a]	Frequency	Abundance (count)	Proportion of households (%)	Main use[b]	Other uses[c]	Edible part(s)	Food type	IUCN status[d]
Solanaceae	*Capsicum annuum* var. Grossum group	Bell pepper	Kaamulali	Herb	E	29	45	39.19	F		Fruit	Vegetable	-
Poaceae	*Cymbopogon citratus* (DC.) Stapf.	Lemon grass	Kisubi	Grass	E	25	43	33.78	F	M	Leaves	Condiment	-
Passifloraceae	*Passiflora edulis* Sims	Passionfruit	Katunda	Herb	E	23	46	31.08	F		Fruit	Fruit	-
Rubiaceae	*Vangueria apiculata* K. Schum.		Mutuggunda	Tree	I	23	62	31.08	F	M, T	Fruit	Fruit	-
Amaryllidaceae	*Allium cepa* L.	Onion & Spring onion	Katungulu	Herb	E	21	242	28.38	F	M	Bulb, leaves	Vegetable	-
Rutaceae	*Citrus limon* (L.) Osbeck	Lemon tree	Nniimu	Tree	E	18	49	24.32	F	M, T	Fruit	Fruit	-
Myrtaceae	*Syzygium cumini* (L.) Skeels	Jambula, Java plum	Jambula	Tree	E	18	43	24.32	F	M, T	Fruit	Fruit	-
Rubiaceae	*Coffea canephora* Pierre ex A. Froehner	Robusta coffee	Mwanyi	Shrub	I	17	59	22.97	F	M, T	Fruit, seeds	Condiment	-
Cleomaceae	*Cleome gynandra* L.	African spiderflower	Jjobyo	Herb	*unclear*	*15*	*137*	20.27	F	M	Leaves	Vegetable	-
Convolvulaceae	*Ipomoea batatas* (L.) Lam.	Sweet potatoes	Lumonde	Shrub	E	15	1710	20.27	F	M, T	Tubers	Starchy staple	-
Rutaceae	*Citrus sinensis* (L.) Osbeck	Sweet orange	Mucungwa	Tree	E	14	34	18.92	F	M	Fruit	Fruit	-
Solanaceae	*Solanum americanum* Mill.	Glossy night shade	Nsugga/ensugga, Nsugga/ensugga enzirugavu	Herb	E	14	27	18.92	F	M	Leaves	Vegetable	-
Dioscoreaceae	*Dioscorea cayennensis* Lam.	Yellow Guinea yam	Kyetutumula, Balugu	Herb	E	12	19	16.22	F		Tubers	Starchy staple	-
Solanaceae	*Solanum aethiopicum* L. var. Gilo group	African eggplant	Ntula	Herb	I	12	47	16.22	F	M, T	Fruit	Vegetable	-
Solanaceae	*Solanum melongena* L.	Eggplant (purple)	Biringanya	Herb	E	12	253	16.22	F		Fruit	Vegetable	-
Arecaceae	*Elaeis guineensis* Jacq.	African oil palm	Munazi	Tree	E	11	16	14.86	F	O, T	Fruit	Oil	LC

Botanical family	Botanical name	Common name	Local name (Luganda)	Growth form	Origin[(a)]	Frequency	Abundance (count)	Proportion of households (%)	Main use[(b)]	Other uses[(c)]	Edible part(s)	Food type	IUCN status[(d)]
Fabaceae	*Phaseolus lunatus* L.	Lima Beans, butter beans	Kayindiyindi, Kigaaga	Herb	E	10	19	13.51	F	M	Seeds, leaves	Legumes	-
Brassicaceae	*Brassica oleracea* L. (var: 1)	Kale	Sukuma wiki	Herb	E	9	89	12.16	F		Leaves	Vegetable	DD
Araceae	*Colocasia esculenta* (L.) Schott	Cocoyams, wetland yam, taro	Bwaise	Herb	E	8	262	10.81	F		Roots	Starchy staple	LC
Solanaceae	*Physalis peruviana* L.	Cape Gooseberry	Ntuntunu	Shrub	E	8	12	10.81	F	M	Fruit	Fruit	-
Annonaceae	*Annona reticulata* L.	Custard apple	Kitaffeeri	Tree	E	7	21	9.46	F	M, T	Fruit	Fruit	-
Dioscoreaceae	*Dioscorea alata* L.	Water yam, white yam	Kisebe & Ndaggu	Herb	E	7	11	9.46	F		Tubers	Starchy staple	-
Amaryllidaceae	*Allium sativum* L.	Garlic	Katungulu Cumu	Herb	E	6	344	8.11	F	M	Bulb, leaves	Vegetable	-
Lamiaceae	*Rosmarinus officinalis* L.	Rosemary		Shrub	E	6	8	8.11	F	M	Leaves	Herb/Spice	-
Poaceae	*Zea mays* L.	Maize	Kasooli	Herb	E	6	154	8.11	F	T	Seeds	Starchy staple (cereals)	-
Phyllanthaceae	*Bridelia micrantha* (Hochst.) Baill.	Bridelia	Katazamiti	Tree	I	5	7	6.76	F	M	Fruit	Fruit	-
Lythraceae	*Punica granatum* L.	Pomegranate	Nkomamawanga	Tree	E	5	5	6.76	F	M, T	Fruit	Fruit	LC
Solanaceae	*Solanum aethiopicum* L. var. Shum group	African Nightshade	Nakati	Herb	I	5	1631	6.76	F		Leaves	Vegetable	-
Amaranthaceae	*Amaranthus tricolor* L.		Bbuga	Herb	E	4	82	5.41	F		Leaves, stem	Vegetable	-
Lamiaceae	*Mentha aquatica* L.	Water mint	Nabbugira	Herb	*unclear*	*4*	*4*	5.41	F	M	Leaves, stem	Herb/Spice	LC
Moraceae	*Morus alba* L.	Mulberry	Nkennene	Tree	E	4	6	5.41	F	T	Fruit	Fruit	-
Cucurbitaceae	*Sechium edule* (Jacq.) Sw.	Chayote, Cho cho	Nsuusuuti	Herb	E	4	6	5.41	F		Fruit	Vegetable	-

Botanical family	Botanical name	Common name	Local name (Luganda)	Growth form	Origin[a]	Frequency	Abundance (count)	Proportion of households (%)	Main use[b]	Other uses[c]	Edible part(s)	Food type	IUCN status[d]
Fabaceae	*Vigna unguiculata* (L.) Walp.	Cowpeas	Gobe, Mpindi	Herb	I	4	191	5.41	F	F	Seeds, leaves	Legumes, leaves	-
Amaranthaceae	*Amaranthus hybridus* L.	Amaranthus spinach	Doodo (exotic)	Herb	E	3	758	4.05	F		Leaves, stem	Vegetable	-
Burseraceae	*Canarium schweinfurthii* Engl.	Insense tree	Muwafu	Tree	I	3	6	4.05	F	M, T	Fruit	Fruit	-
Solanaceae	*Capsicum annuum* L.	Chili pepper		Herb	E	3	87	4.05	F	M	Fruit	Herb/Spice	-
Cucurbitaceae	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	Watermelon		Herb	E	3	5	4.05	F		Fruit	Fruit	-
Zingiberacaea	*Curcuma longa* L.	Turmeric	Kinzaali	Herb	E	3	13	4.05	F	M	Roots	Spice	-
Bromeliaceae	*Ananas comosus* (L.) Merr.	Pineapple	Nanansi	Herb	E	2	5	2.70	F		Fruit	Fruit	-
Brassicaceae	*Brassica oleracea* L. (var: 2)	Leaf cabbage	Mboga, Saaga	Herb	E	2	16	2.70	F		Leaves	Vegetable	DD
Myrtaceae	*Eugenia uniflora* L.	Surinam cherry	Musaali (small)	Tree	E	2	4	2.70	F	T	Fruit	Fruit	-
Solanaceae	*Solanum tuberosum* L.	Irish potato	Bumonde obuzungu	Herb	E	2	2	2.70	F		Tubers	Starchy staple	-
Fabaceae	*Vigna vexillata* (L.) A. Rich.	Zombi pea	Nalongolugaba	Herb	I	2	71	2.70	F	M, O	Seeds	Legumes	-
Malvaceae	*Abelmoschus esculentus* (L.) Moench	Okra		Herb	E	1	1	1.35	F	M	Fruit	Vegetable	-
Zingiberacaea	*Aframomum angustifolium* (Sonn.) K. Schum	Guinea Grains	Amatungulu	Herb	I	1	3	1.35	F		Roots	Herb/Spice	LC
Lauraceae	*Cinnamomum verum* J. Presl	Cinnamon	Budalasiini	Tree	E	1	1	1.35	F	T	Bask	Spice	-
Rutaceae	*Citrus reticulata* Blanco	Tangerines	Mangada	Tree	E	1	4	1.35	F		Fruit	Fruit	-
Apiaceae	*Daucus carota* subsp. *sativus* (Hoffm.) Arcang.	Carrots		Herb	E	1	1	1.35	F		Roots	Vegetable	DD
Rosaceae	*Eriobotrya japonica* (Thunb.) Lindl.	Loquat	Musaali (big)	Tree	E	1	1	1.35	F		Fruit	Fruit	-

Botanical family	Botanical name	Common name	Local name (Luganda)	Growth form	Origin[a]	Frequency	Abundance (count)	Proportion of households (%)	Main use[b]	Other uses[c]	Edible part(s)	Food type	IUCN status[d]
Lamiaceae	*Mentha × piperita* L.	Peppermint		Herb	E	1	1	1.35	F		Leaves, stem	Herb/Spice	-
Lamiaceae	*Mentha suaveolens* Ehrh.	Apple mint		Herb	E	1	1	1.35	F		Leaves, stem	Herb/Spice	LC
Passifloraceae	*Passiflora quadrangularis* L.	Giant granadilla	Wujju	Herb	E	1	1	1.35	F		Fruit	Fruit	-
Solanaceae	*Solanum betaceum* Cav.	Tree tomato	Kinyaanya	Shrub	E	1	4	1.35	F		Fruit	Fruit	DD
Malvaceae	*Theobroma cacao* L.	Cocoa	Kooko	Tree	E	1	3	1.35	F		Fruit, seeds	Condiment	-
Zingiberacaea	*Zingiber officinale* Roscoe	Ginger	Ntangawuzi	Herb	E	1	1	1.35	F	M	Roots	Condiment	-
MEDICINAL													
Xanthorrhoeaceae	*Aloe vera* (L.) Burm.f.	Aloe vera	Kigagi	Herb	E	39	342	52.70	M	O			-
Asteraceae	*Vernonia amygdalina* Delile	Bitter leaf	Mululuuza	Shrub	I	29	96	39.19	M	T			-
Amaranthaceae	*Chenopodium opulifolium* Schrad. ex W.D.J. Koch & Ziz	Pigweed	Mwetango	Herb	I	22	81	29.73	M				-
Amaranthaceae	*Aerva lanata* (L.) Juss.	Mountain knotgrass	Lweza	Herb	I	21	178	28.38	M	O			-
Asteraceae	*Solanecio mannii* (Hook.f.) C. Jeffrey		Kiralankuba	Shrub	I	21	57	28.38	M				-
Amaranthaceae	*Dysphania ambrosioides* (L.) Mosyakin & Clemants	Mexican tea	Kattaddogo, Kawunyira	Shrub	E	20	148	27.03	M				-
Phyllanthaceae	*Phyllanthus ovalifolius* Forssk.		Mutulika	Shrub	I	18	37	24.32	M	O, T			-
Acanthaceae	*Justicia betonica* L.	Paper plume, White shrimp family	Nalongo	Herb	I	16	46	21.62	M				-
Lamiaceae	*Plectranthus barbatus* Andrews	Coleus	Kibwankulata	Herb	E	16	23	21.62	M				-

Botanical family	Botanical name	Common name	Local name (Luganda)	Growth form	Origin[(a)]	Frequency	Abundance (count)	Proportion of households (%)	Main use[(b)]	Other uses[(c)]	Edible part(s)	Food type	IUCN status[(d)]
Crassulaceae	*Kalanchoe densiflora* Rolfe		Kiyondo ekiyeru (light green)	Herb	I	15	24	20.27	M				-
Cucurbitaceae	*Momordica foetida* Schumach.	Snake food, wild cucumber	Bbombo	Herb	I	15	30	20.27	M	F			-
Malvaceae	*Hibiscus sabdariffa* L.	Rosella	Musaayi gwadeezi	Herb	I	14	53	18.92	M	F			-
Asteraceae	*Cyanthillium cinereum* (L.) H. Rob.	Little iron weed	Kayayana	Herb	I	11	80	14.86	M				-
Acanthaceae	*Justicia heterocarpa* T. Anderson		Kalaaza	Herb	I	11	78	14.86	M	O			-
Lamiaceae	*Leonotis nepetifolia* (L.) R.Br.	Lion's ear	Kifumufumu	Herb	I	11	69	14.86	M	O, T			-
Fabaceae	*Senna occidentalis* (L.) Link	Coffee senna	Muttanjoka	Shrub	E	11	53	14.86	M	F, O			-
Morangaceae	*Moringa oleifera* Lam.	Drumstick tree		Tree	E	10	13	13.51	M	F, T			-
Crassulaceae	*Bryophyllum pinnatum* (Lam.) Oken	Cathedral bells	Ngalomwenda, Kiyondo kidugavu (green)	Herb	I	9	62	12.16	M	O, T			-
Verbanaceae	*Lantana camara* L.	Wild sage	Kayuukiyuuki	Shrub	E	9	33	12.16	M	F, O, T			-
Lamiaceae	*Plectranthus amboinicus* (Lour.) Spreng.	Country borage	Mubiri (small), Kamubiri	Herb	I	9	41	12.16	M	O			-
Lamiaceae	*Tetradenia riparia* (Hochst.) Codd	Ginger Bush	Kyewamala	Shrub	I	9	14	12.16	M	T			-
Fabaceae	*Abrus precatorius* L.	Rosary pea, jequirity bean	Nsiiti, Lusiiti	Herb	I	8	19	10.81	M	O, T			-
Asteraceae	*Ageratum conyzoides* (L.) L.	Goat weed	Namirembe	Herb	E	8	71	10.81	M	M			-
Apocynaceae	*Catharanthus roseus* (L.) G. Don	Rosy periwinkle, rosenca	Ssekaggye	Herb	E	8	44	10.81	M	O			-

Botanical family	Botanical name	Common name	Local name (Luganda)	Growth form	Origin[a]	Frequency	Abundance (count)	Proportion of households (%)	Main use[b]	Other uses[c]	Edible part(s)	Food type	IUCN status[d]
Asteraceae	*Conyza sumatrensis* (S.F. Blake) Pruski & G. Sancho	Tall fleabane	Kafumbe	Herb	E	8	33	10.81	M	T			-
Euphorbiaceae	*Euphorbia heterophylla* L.	Wild poinsettia	Kisanda	Herb	E	8	531	10.81	M	T			-
Phyllanthaceae	*Flueggea virosa* (Roxb. ex Willd.) Royle	White berrry bush	Lukandwa	Shrub	I	8	41	10.81	M	T			-
Lamiaceae	*Hoslundia opposita* Vahl	Orange bird berry	Kamunye	Shrub	I	8	13	10.81	M	F			-
Lamiaceae	*Ocimum forsskaolii* Benth.		Kakubajjiri, Kakubansiri	Herb	E	8	91	10.81	M				-
Euphorbiaceae	*Ricinus communis* L.	Castor oil	Nsogasoga	Shrub	E	8	36	10.81	M	T			-
Sapindaceae	*Cardiospermum halicacabum* L.	Balloon vine	Kambula	Herb	*unclear*	*7*	*11*	9.46	M				-
Plantaginaceae	*Plantago palmata* Hook. F.		Bukumbunkuyeg ekuggi	Herb	I	7	22	9.46	M	F, T			-
Myrtaceae	*Callistemon citrinus* (Curtis) Skeels	Bottlebrush	Mwambalabuton nya	Tree	E	6	10	8.11	M	O			-
Asteraceae	*Dichrocephala integrifolia* (L.f.) Kuntze		Bbuza	Herb	*unclear*	*6*	*44*	8.11	M				-
Acanthaceae	*Justicia engleriana* Lindau		Muwanga	Shrub	I	6	14	8.11	M	T			-
Asteraceae	*Bothriocline longipes* (Oliv. & Hiern) N.E.Br.		Twatwa	Herb	I	5	10	6.76	M				-
Polygonaceae	*Rumex usambarensis* (Dammer) Dammer		Kisekeseke	Shrub	I	5	44	6.76	M				-
Aristolochiaceae	*Aristolochia littoralis* Parodi	Elegant Dutchman's pipe	Nakasero, Kasero	Herb	E	4	9	5.41	M				-
Vitaceae	*Cyphostemma adenocaule* (Steud. ex A. Rich.) Desc. ex Wild & R.B. Drumm.		Kabombo	Herb	I	4	5	5.41	M	T			-
Acanthaceae	*Dicliptera laxata* C.B. Clarke		Muzuukizi	Shrub	I	4	68	5.41	M				-

Botanical family	Botanical name	Common name	Local name (Luganda)	Growth form	Origin[(a)]	Frequency	Abundance (count)	Proportion of households (%)	Main use[(b)]	Other uses[(c)]	Edible part(s)	Food type	IUCN status[(d)]
Poaceae	*Pennisetum purpureum* Schumach.	Elephant grass, Napier grass		Grass	I	4	18	5.41	M	T			LC
Solanaceae	*Solanum incanum* L.	Bitter apple	Katengotengo	Herb	I	4	55	5.41	M				-
Asteraceae	*Sonchus oleraceus* (L.) L.	Milk thistle	Kawomerambuzi, Kattakkovu	Herb	E	4	4	5.41	M	T			-
Asteraceae	*Tagetes minuta* L.	Stinking Roger	Kawunyira	Herb	E	4	15	5.41	M				-
Talinaceae	*Talinum portulacifolium* (Forssk.) Asch. ex Schweinf.	Flameflower, jewels of Opar	Mpoza	Herb	I	4	222	5.41	M				LC
Malvaceae	*Urena lobata* L.	Ceasar weed	Muwugula	Shrub	E	4	42	5.41	M				-
Malvaceae	*Abutilon mauritianum* (Jacq.) Medik.	Bush mallow	Kifuula	Shrub	I	3	4	4.05	M				-
Apocynaceae	*Caralluma commutata* A. Berger		Kawulira	Herb	*unclear*	*3*	*45*	4.05	M				-
Solanaceae	*Datura stramonium* L.	Thorn apple	Maduudu	Herb	E	3	4	4.05	M				-
Asparagaceae	*Dracaena steudneri* Engl.	Northern large-leaved dragon-tree	Kajjolyenjovu	Tree	I	3	3	4.05	M				-
Oxalidaceae	*Oxalis corniculata* L.	Creeping woodsorrel, procumbent yellow-sorrel	Kajjampuni	Herb	E	3	33	4.05	M				-
Asteraceae	*Sigesbeckia orientalis* L.	Common St. Pauls wort	Sseziwundu	Herb	I	3	47	4.05	M				-
Apiaceae	*Centella asiatica* (L.) Urb.	Centella, Indian pennyworth	Kutukumu/ Mbutamo/ Kabbokabakyala	Herb	E	2	11	2.70	M				LC
Lamiaceae	*Clerodendrum rotundifolium* Oliv.		Kisekeseke 2	Herb	*unclear*	*2*	*16*	2.70	M				-
Fabaceae	*Crotalaria pallida* Aiton	Smooth Rattlebox	Namuli	Herb	I	2	25	2.70	M	F			-

Botanical family	Botanical name	Common name	Local name (Luganda)	Growth form	Origin[a]	Frequency	Abundance (count)	Proportion of households (%)	Main use[b]	Other uses[c]	Edible part(s)	Food type	IUCN status[d]
Fabaceae	*Desmodium adscendens* (Sw.) DC.	Silver leaf	Mutasukkakkubo	Herb	I	2	2	2.70	M	T			LC
Phytolaccaceae	*Hilleria latifolia* (Lam.) H. Walter		Musayimuto	Herb	E	2	8	2.70	M	T			-
Fabaceae	*Indigofera arrecta* A. Rich.	Natal indigo	Kabambamaliba	Herb	I	2	2	2.70	M				-
Acanthaceae	*Justicia exigua* S. Moore		Kazunzanjuki	Herb	I	2	5	2.70	M	T			-
Asteraceae	*Laggera alata* Nanth.		Muzikiza	Herb	I	2	4	2.70	M				-
Asteraceae	*Microglossa pyrifolia* (Lam.) Kuntze		Kafugankande, Akafugankande	Shrub	I	2	3	2.70	M				-
Loranthaceae	*Phragmanthera cornetii* (Dewèvre) Polhill & Wiens		Nzirugaze	Herb	*unclear*	*2*	*5*	2.70	M				-
Phyllanthaceae	*Phyllanthus fraternus* G.L. Webster	Gripe weed	Kabaliramugong o	Herb	*unclear*	*2*	*29*	2.70	M				-
Portulacaceae	*Portulaca quadrifida* L.	Small leaved purslane, single-flowered purslane	Bwanda	Herb	I	2	10	2.70	M	M			-
Asteraceae	*Senecio syringifolius* O. Hoffm		Kimenyamagamb a	Herb	I	2	2	2.70	M				-
Fabaceae	*Senna didymobotrya* (Fresen.) H.S. Irwin & Barneby	African senna, candelabra tree, Candle bush	Mucuula	Shrub	I	2	10	2.70	M				-
Asteraceae	*Solanecio cydoniifolius* (O. Hoffm.) C. Jeffrey		Kivuuvu	Herb	I	2	2	2.70	M				-
Solanaceae	*Solanum aculeastrum* Dunal	Poison apple	Ntengotengo (big)	Shrub	I	2	3	2.70	M				-
Asteraceae	*Vernonia auriculifera* Hiern		kikookooma	Shrub	I	2	2	2.70	M	T			-
Euphorbiaceae	*Acalypha bipartita* Müll.Arg.		Jerengesa	Shrub (scrambl ing sub shrub)	I	1	4	1.35	M				-

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Amaranthaceae	*Achyranthes aspera* L.	Devil's horsewhip	Lukwata, Sikuvirakawo	Herb	I	1	5	1.35	M				-
Asteraceae	*Artemisia absinthium* L.	Common wormwood, Absinth	Lukiiko	Herb	E	1	1	1.35	M				-
Meliaceae	*Azadirachta indica* A. Juss.	Neem		Tree	E	1	1	1.35	M	T			-
Asteraceae	*Bidens pilosa* L.	Black Jack	Sere	Herb	E	1	3	1.35	M				-
Oxalidaceae	*Biophytum abyssinicum* Steud. ex A. Rich.		Kabaliramugong o	Herb	I	1	8	1.35	M				-
Sapindaceae	*Blighia unijugata* Baker	Triangle tops	Mukuzannyana	Tree	I	1	3	1.35	M				-
Fabaceae	*Caesalpinia pulcherrima* (L.) Sw.	Peacock flower		Shrub	E	1	1	1.35	M	O			-
Asparagaceae	*Chlorophytum tuberosum* (Roxb.) Baker	Safed musli	Kattulula	Herb	I	1	5	1.35	M	T			LC
Menispermaceae	*Cissampelos mucronata* A. Rich.	Hairy heartleaf	Kavawala	Herb	I	1	1	1.35	M				-
Commelinaceae	*Commelina africana* L.	Wandering jew	Nanda	Herb	I	1	1	1.35	M	O			LC
Asteraceae	*Crassocephalum vitellinum* (Benth.) S. Moore		Kitonto	Herb	I	1	1	1.35	M				-
Amaranthaceae	*Dysphania procera* (Hochst. ex Moq.) Mosyakin & Clemants	Mugosola	Mugosoola	Herb	I	1	1	1.35	M				-
Myrtaceae	Eucalyptus spp	Eucalyptus, gumtree	Kalittunsi	Tree	E	1	2	1.35	M				x
Euphorbiaceae	*Euphorbia grantii* Oliv.	African milkbush	Nabanteta	Shrub	I	1	2	1.35	M				-
Euphorbiaceae	*Euphorbia hirta* L.	Snakeweed	Akasandasanda, Akasanda (akawansi)	Herb	E	1	1	1.35	M				-
Euphorbiaceae	*Euphorbia tirucalli* L.	Finger Euphorbia	Lukoni	Tree	I	1	2	1.35	M				LC

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Asteraceae	*Gynura scandens* O. Hoffm		Maanyi	Herb	I	1	1	1.35	M				-
Convolvulaceae	*Ipomoea wightii* (Wall.) Choisy		Ddukekibabu	Herb	I	1	360	1.35	M				-
Crassulaceae	*Kalanchoe marnieriana* H. Jacobsen		Ddimilyambwa	Herb	*unclear*	*1*	*1*	1.35	M				-
Asteraceae	*Kleinia abyssinica* (A. Rich.) A. Berger		Kitimagudu, kitimadooko	Herb	I	1	1	1.35	M				-
Polygonaceae	*Oxygonum sinuatum* (Hochst. & Steud ex Meisn.) Dammer		Kafumitabagenge / Kafumitabagend a	Herb	I	1	3	1.35	M				-
Pyllanthaceae	Phyllanthus spp		Mukisesangwe	Herb	*unclear*	*1*	*6*	1.35	M	O			x
Lamiaceae	*Plectranthus bojeri* (Benth.) Hedge		Mubiri (big)	Herb	I	1	1	1.35	M				-
Portulacaceae	*Portulaca oleracea* L.	Purslane	Ssezira	Herb	E	1	19	1.35	M	M			-
Verbanaceae	*Priva cordifolia* (L.f.) Druce		Nkami	Herb	I	1	2	1.35	M				-
Solanaceae	*Solanum macrocarpon* L.	African eggplant	Numeyakyalo	Herb	I	1	1	1.35	M				-
Malvaceae	*Triumfetta rhomboidea*	Paroquet bur	Muwugula (small)	Herb	E	1	1	1.35	M				-
	Unidentified 02			Herb	*unclear*	*1*	*2*	1.35	M				x
	Unidentified 03			Herb	*unclear*	*1*	*2*	1.35	M				x
	Unidentified 05		Kittavvu	Herb	*unclear*	*1*	*1*	1.35	M				x
	Unidentified 14		Sekabembe	Herb	*unclear*	*1*	*1*	1.35	M	T			x
ORNAMENTAL													
Euphorbiaceae	*Acalypha wilkesiana* Müll.Arg.	Dragon plant		Shrub	E	7	22	9.46	O				-
Asparagaceae	*Sansevieria dawei* Stapf			Herb	I	7	59	9.46	O				-

Botanical family	Botanical name	Common name	Local name (Luganda)	Growth form	Origin[(a)]	Frequency	Abundance (count)	Proportion of households (%)	Main use[(b)]	Other uses[(c)]	Edible part(s)	Food type	IUCN status[(d)]
Araceae	*Caladium bicolor* (Aiton) Vent.	Elephant ear		Herb	E	5	22	6.76	O				-
Asparagaceae	*Asparagus africanus* Lam.	Wild asparagus	Kadaali	Shrub	I	4	6	5.41	O	T			-
Fabaceae	*Calliandra brevipes* Benth.	Pink powderpuff		Shrub	E	4	7	5.41	O				-
Lamiaceae	*Vitex trifolia* L.			Shrub	*unclear*	*4*	*19*	5.41	O	T			-
Asparagaceae	*Chlorophytum cameronii* (Baker) Kativu	Common Spiderplant		Herb	I	3	18	4.05	O				-
Euphorbiaceae	*Codiaeum variegatum* (L.) Rumph. ex A. Juss.	Garden croton		Shrub	E	3	28	4.05	O	T			-
Rosaceae	*Rosa* Spp	Rose bush		Shrub	E	3	25	4.05	O	F, M			x
Iridaceae	*Watsonia* spp			Herb	E	3	4	4.05	O	T			x
Nyctaginaceae	*Bougainvillea spectabilis* Willd.	Bougainvillea		Shrub	E	2	2	2.70	O				-
Asparagaceae	*Cordyline fruticosa* (L.) A. Chev.	Cabbage palm		Shrub	E	2	7	2.70	O				-
Amaryllidaceae	*Hippeastrum hybridum*	Amaryllis		Herb	E	2	3	2.70	O				-
Rubiaceae	*Oxyanthus lepidus* S. Moore			Shrub	I	2	4	2.70	O				-
Commelinaceae	*Tradescantia zebrina* Bosse	Wandering jew, Silver Inch plant		Herb	E	2	3	2.70	O				-
Apocynaceae	*Apocynum* spp	Dogbane, Indian hemp		Herb	E	1	1	1.35	O				x
Cyperaceae	*Cyperus involucratus* Rottb.	Umbrella plant, umbrella papyrus		Herb	I	1	2	1.35	O	T			-
Poaceae	*Phragmites karka* (Retz.) Trin. ex Steud.	Reed		Grass	I	1	2	1.35	O				-
Apocynaceae	*Strophanthus Hispidus* DC.	Brown Strophanthus		Shrub	I	1	1	1.35	O				-
Bignoniaceae	*Tabebuia heterophylla* (DC.) Britton	Pink trumpet tree		Tree	E	1	1	1.35	O				-

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	Unidentified 09			Herb	*unclear*	*1*	*12*	1.35	O				x
	Unidentified 10			Herb	*unclear*	*1*	*5*	1.35	O				x
	Unidentified 11			Herb	*unclear*	*1*	*11*	1.35	O				x
	Unidentified 12		Kimuli	Herb	*unclear*	*1*	*1*	1.35	O				x
Technical													
Malvaceae	*Melochia corchorifolia* L.	Chocolate weed	Keyeeyo	Herb	I	40	1105	54.05	T	M, O			-
Bignoniaceae	*Markhamia lutea* (Benth.) K. Schum.	Markhamia, Nile tulip, Nile Trumpet, Niala Tree	Musambya	Tree	I	36	229	48.65	T	M			-
Solanaceae	*Nicotiana tabacum* L.	Tobacco	Taaba	Herb	E	32	156	43.24	T	M			-
Moraceae	*Ficus natalensis* Hochst.	bark cloth fig, bark cloth tree	Mutuba	Tree	I	17	33	22.97	T	M			-
Moraceae	*Ficus laurifolia* Lam.		Mukookoowe	Shrub	I	16	23	21.62	T	M			-
Euphorbiaceae	*Shirakiopsis elliptica* (Hochst.) Esser	Jumping seed tree	Musasa	Tree	I	14	22	18.92	T	M, O			-
Asparagaceae	*Dracaena fragrans* (L.) Ker Gawl.	Cornstalk dracaena	Luwaanyi/Mula mula	Shrub	I	13	59	17.57	T	F, M			-
Moraceae	*Ficus exasperata* Vahl	Forest sandpaper fig	Luwawu	Shrub	I	13	17	17.57	T	M			-
Cucurbitaceae	*Luffa cylindrica* (L.) M. Roem.	Loofah, sponge gourd	Kyangwe	Herb	E	13	57	17.57	T	M			-
Lamiaceae	*Premna resinosa* (Hochst.) Schauer			Shrub	I	10	88	13.51	T	M, O			-
Fabaceae	*Senna spectabilis* (DC.) H.S. Irwin & Barneby	Cassia	Gasiya	Tree	E	10	19	13.51	T				LC
Malvaceae	*Hibiscus hybridus* F. Dietr.			Shrub	E	9	57	12.16	T	M, O			-
Euphorbiaceae	*Jatropha curcas* L.	Jatropha	Kiroowa	Shrub	E	9	14	12.16	T	M			-

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Cupressaceae	*Cupressus lusitanica* Mill.	East African cypress	Kakomera	Tree	E	7	20	9.46	T	M, O			LC
Moraceae	*Antiaris toxicaria* Lesch.	Antiaris	Kirundu	Tree	I	5	19	6.76	T				-
Euphorbiaceae	*Maranta leuconeura* E. Morren	Prayer plant		Herb	E	5	14	6.76	T	O			-
Asteraceae	*Crassocephalum crepidioides* (Benth.) S. Moore	Fireweed	Ssekkoteka	Herb	I	4	7	5.41	T				-
Fabaceae	*Entada abyssinica* A. Rich.	Tree entanda	Mwolola	Tree	I	4	5	5.41	T	O			-
Fabaceae	*Leucaena leucocephala* (Lam.) de Wit	White Popinac Tree	Luwalira	Tree	E	4	8	5.41	T	O			-
Rhamnaceae	*Maesopsis eminii* Engl.	Umbrella tree	Musizi	Tree	I	4	5	5.41	T				-
Poaceae	*Panicum maximum* Jacq.	Guinnea grass	Mukonzikonzi	Grass	I	4	254	5.41	T				-
Euphorbiaceae	*Aleurites moluccanus* (L.) Willd.	Candlenut	Kabakanjagala	Tree	E	3	4	4.05	T	O			-
Fabaceae	*Calliandra calothyrsus* Meisn.	Red calliandra		Tree	E	3	78	4.05	T	M			-
Apocynaceae	*Cascabela thevetia* (L.) Lippold	Yellow oleander	Kasitaani	Shrub	E	3	134	4.05	T	O			-
Euphorbiaceae	*Hevea brasiliensis* (Willd. ex A. Juss.) Müll.Arg.	Rubber tree	Pala	Tree	E	3	3	4.05	T				-
Cactaceae	Opuntia spp		Ngaboyakawump uli	Herb	E	3	6	4.05	T	M, O			x
Bignoniaceae	*Spathodea campanulata* P. Beauv.	African tulip tree	Kifabakazi	Tree	I	3	166	4.05	T				-
Urticaceae	*Urtica dioica* L.	Nettle	Mwennyango	Herb	E	3	38	4.05	T	M			LC
Cannaceae	*Canna indica* L.	Edible canna, Achira, Indian shot, African arrowroot	Malanga, syn: Canna edulis	Herb	E	2	7	2.70	T				-
Bignoniaceae	*Jacaranda mimosifolia* D. Don	Jacaranda		Tree	E	2	2	2.70	T	O			VU

Botanical family	Botanical name	Common name	Local name (Luganda)	Growth form	Origin[(a)]	Frequency	Abundance (count)	Proportion of households (%)	Main use[(b)]	Other uses[(c)]	Edible part(s)	Food type	IUCN status[(d)]
Marantaceae	*Marantochloa purpurea* (Ridl.) Milne. Redh.	Yoruba softcane	Njulu	Herb	I	2	28	2.70	T	O			-
Fabaceae	*Mundulea sericea* (Wild) A. Chev		Lumanyo	Tree	I	2	2	2.70	T	M			-
Araliaceae	*Polyscias fulva* (Hiern) Harms		Ssettala	Tree	I	2	2	2.70	T				-
Rubiaceae	*Psydrax schimperiana* (A. Rich.) Bridson		Kamwanyimwanyi	Shrub	I	2	3	2.70	T				-
Rutaceae	*Vepris nobilis* (Delile) Mziray		Nzo	Tree	I	2	6	2.70	T				-
Fabaceae	*Acacia hockii* De Wild.	White thorn Acacia	Kasaana	Tree	I	1	1	1.35	T				-
Fabaceae	*Albizia coriaria* Welw. Ex Oliv.		Mugavu	Tree	I	1	1	1.35	T	M			-
Fabaceae	*Albizia zygia* (DC.) J.F. Macbr.	Red nongo	Nnongo	Tree	I	1	2	1.35	T				-
Moraceae	*Broussonetia papyrifera* (L.) L'Hér. ex Vent.	Paper mulberry		Shrub	E	1	5	1.35	T				-
Fabaceae	*Cassia grandis* L.f.	Pink shower tree		Tree	E	1	1	1.35	T				-
Thelypteridaceae	*Christella parasitica* (L.) Levielle		Kayongo	Herb	E	1	1	1.35	T				-
Boraginaceae	*Cynoglossum virginianum* L.	Wild comfrey	Kimerekyenkoko	Herb	E	1	3	1.35	T	F, O			-
Fabaceae	*Erythrina abyssinica* Lam. Ex DC.	red hot poker tree	Jjirikiti	Tree	I	1	4	1.35	T	M			-
Capparaceae	*Maerua duchesnei* (De Wild.) F. White			Tree	I	1	1	1.35	T				-
Moraceae	*Milicia excelsa* (Welw.) C.C. Berg	African teak	Muvule	Tree	I	1	2	1.35	T	M			NT
Oxalidaceae	*Oxalis latifolia* Kunth	Broadleaf woodsorrel	Kanyebwa (Omusajja)	Herb	E	1	148	1.35	T				-
Arecaceae	*Phoenix reclinata* Jacq.	Senegal date palm	Lukindukindu, Lukomakoma	Tree	I	1	1	1.35	T				-

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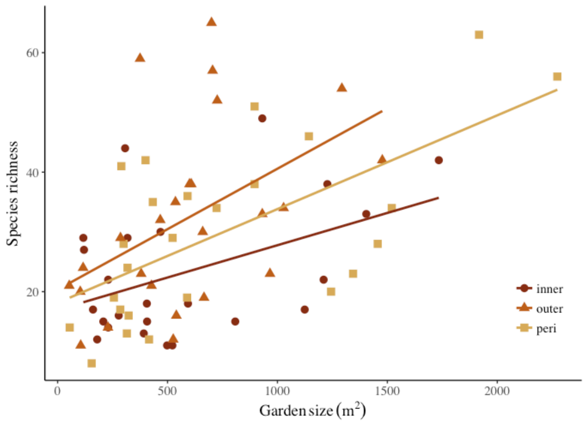
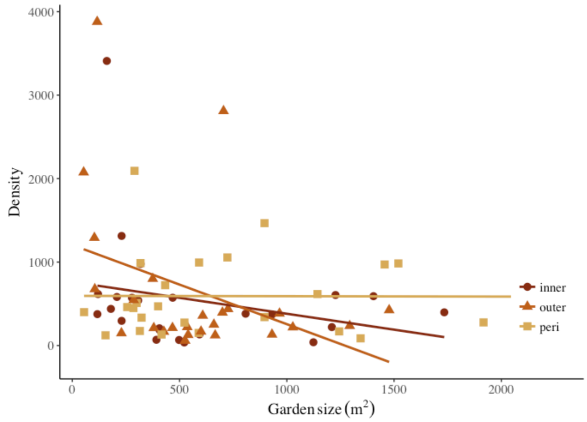
Apocynaceae	*Rauvolfia vomitoria* Afzel.	African snakeroot		Shrub	I	1	1	1.35	T	O			-
Fabaceae	*Sesbania sesban* (L.) Merr.	Sesban	Mubimba	Shrub	I	1	1	1.35	T	M			-
Malvaceae	*Sida rhombifolia* L.	Broom Jute	Luvunvu	Shrub	I	1	10	1.35	T				-
Combretaceae	*Terminalia ivorensis* A. Chev.	"Umbrella tree", Black Afara		Tree	E	1	2	1.35	T				VU
Asteraceae	*Tithonia diversifolia* (Hemsl.) A. Gray	Tithonia, Tree marigold	Kimyula	Shrub	E	1	14	1.35	T				-
Meliaceae	*Toona ciliata* M. Roem	Toon tree	Kiwafuwafu	Tree	E	1	1	1.35	T				LC

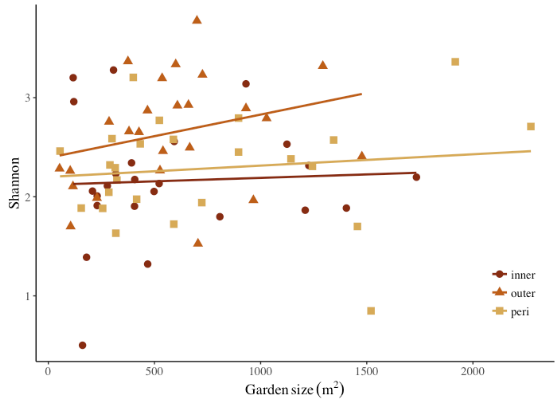
Nomenclature follows The Plantlist (*www.theplantlist.org*).
[a] E = exotic, I = indigenous
[b] F = food, M = medicinal, O = ornamental, T = technical
[c] Conservation status IUCN: LC = least concern, NT = near threatened, VU = vulnerable, DD = data deficient, - = taxon has not yet been assessed for IUCN red list, x = non applicable

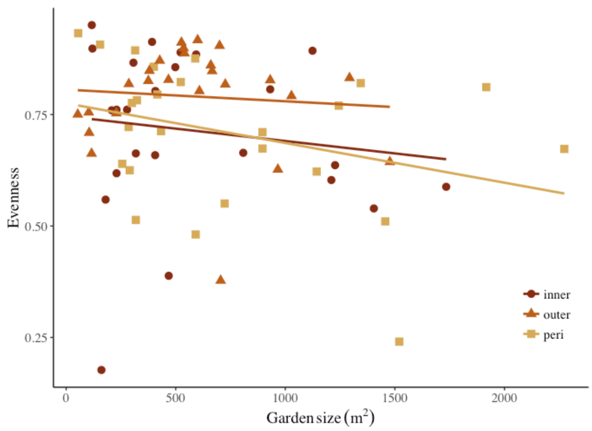
Supplement 2: Various scatter plots of variables with garden size in Kampala.

Pearson: r = 0.507; p < 0.001



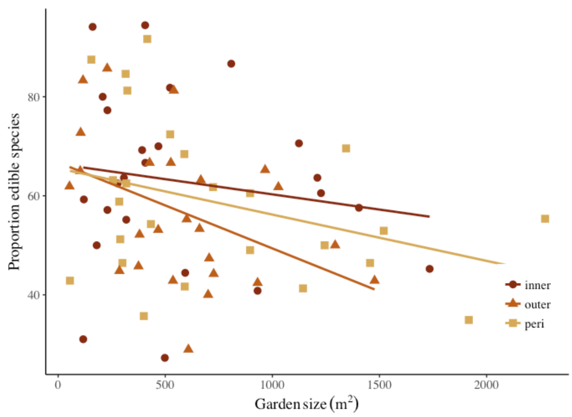


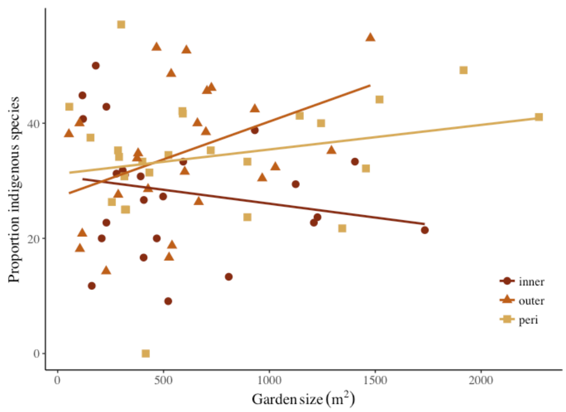




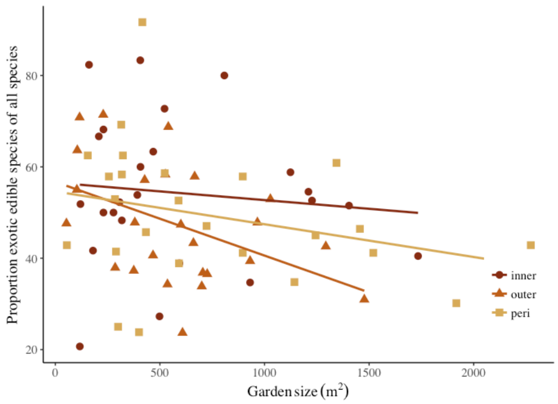
Pearson: r = -0.293, df =71, p = 0.01

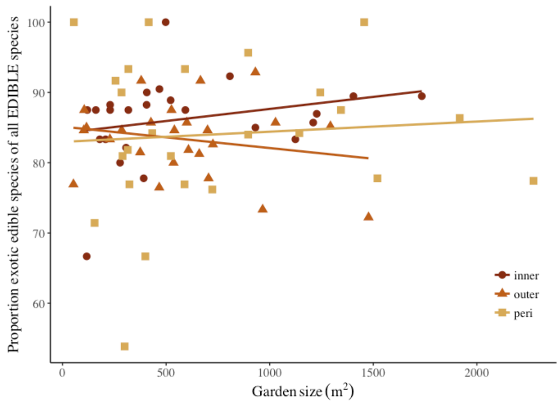
Pearson: r = 0.155, df = 72, p = 0.19

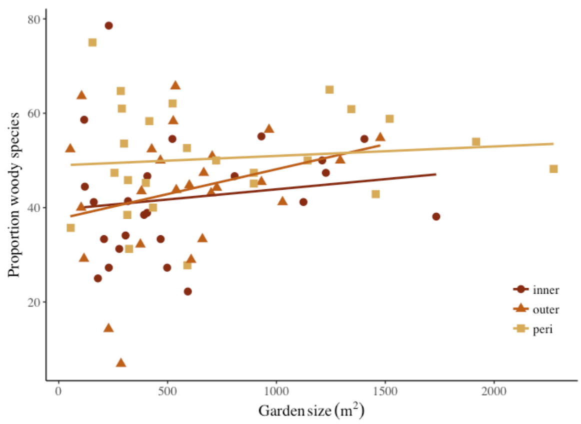


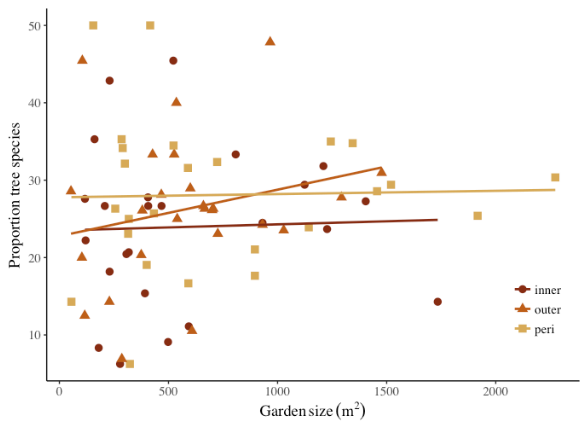


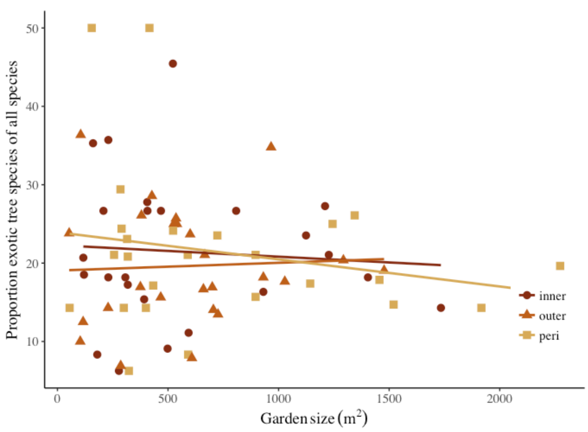
Supplement 2 continued

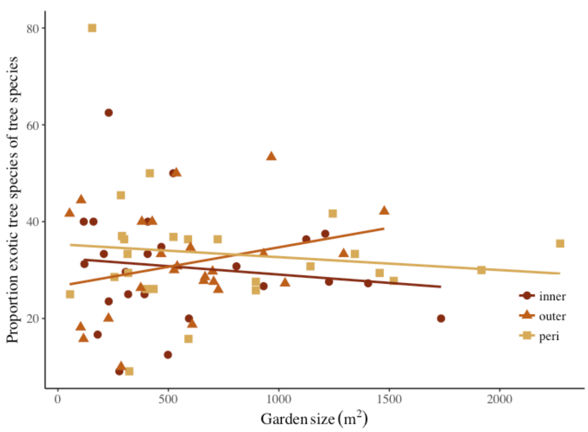












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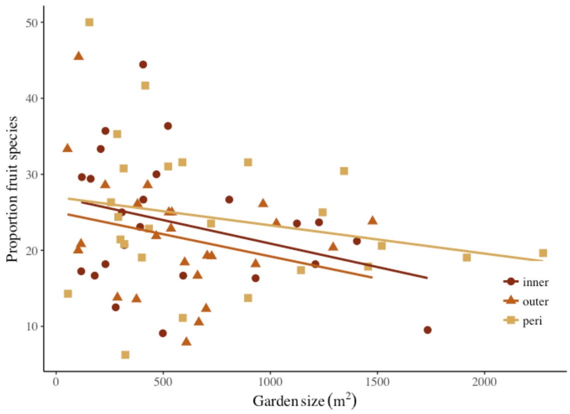
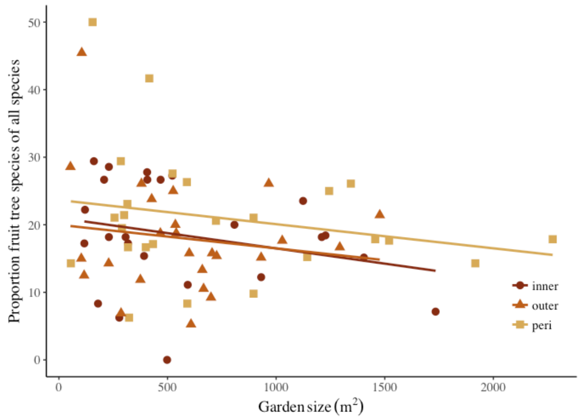
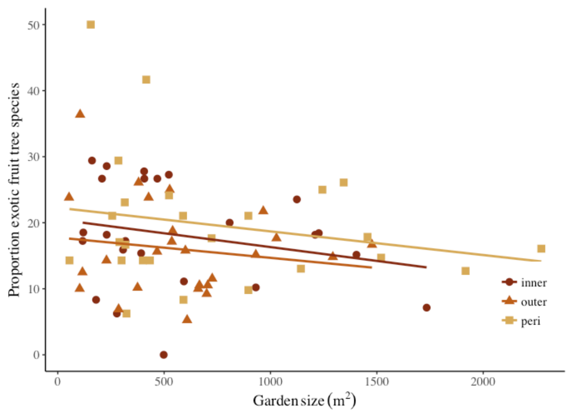
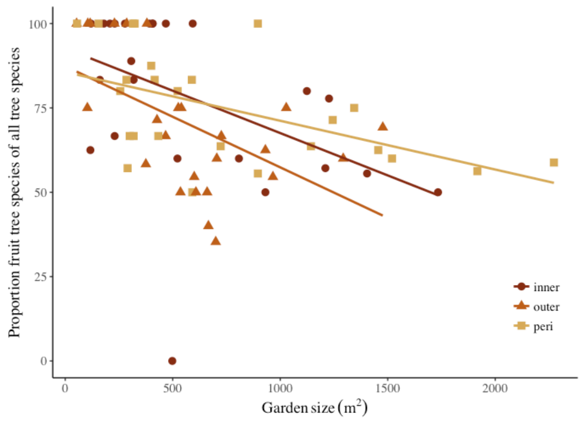




Pearson: r = -0.456, df =72, p < 0.001





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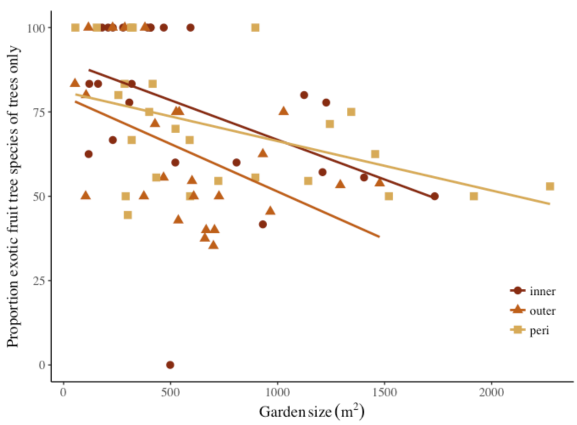

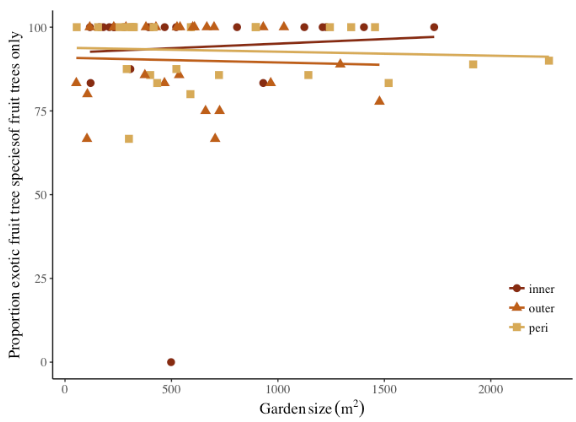

5 Diversifying urban diets: Do homegardens contribute to dietary diversity and increased fruit consumption for children in Uganda?

Abstract

With some of the highest urbanisation rates in the world, sub-Saharan Africa faces serious challenges in providing sufficient, healthy and affordable foods for its growing urban populations. Urban dietary transitions indicate reduced intake of fresh fruit and vegetables which can cause severe micro-nutrient deficiencies. One strategy to increase household food security is through urban food production, however little is known about the specific role of fruit and vegetables in this coping mechanism. The aim of this paper is to explore dietary determinants of children (aged 2-5 years) in Kampala, Uganda. This study focussed specifically on 1) fruit consumption 2) their sources, and 3) the contribution of homegarden richness to dietary diversity. A repeat 24-hour dietary recall was conducted with 49 index children (aged 2-5) and 31 of their respective female caretakers (aged 18-49). For each individual, a Dietary Diversity Score (DDS) based on nine food groups and a Food Variety Score (FVS) was calculated. Anthropometric measurements were taken from each index child and caretaker (to calculate HAZ, WAZ and WAH), and respondents were interviewed on socio-economic data, household food insecurity levels (HFIAS) and food sources. Edible plant species richness and diversity were used for potential garden contributions, and a unique agrobiodiversity indicator was created. The results indicated a correlation between child and caretaker for DDS, FVS and fruit intake. A logistic regression indicated that children from wealthier households were more likely to have higher DDS and fruit intake. Although no direct correlation was found between garden agrobiodiversity and child nutrition in this study, it does not mean that it is the same during harvest season. However, homegardens still provided 5% of the food items consumed during the repeat 24-hour recall. To ensure a more food secure city, researchers, policy makers and urban planners need to become aware of the potential of these urban homegardens and incorporate them in future urban development plans.

5.1 Introduction

Urban food security remains one of the major challenges faced today (IFPRI 2016) despite FAO's warnings of the fast-growing group of people among the urban poor suffering from malnutrition 15 years ago (FAO 2001). Urban dietary transitions indicate reduced intake of fresh fruit and vegetables which can cause severe micro-nutrient deficiencies (Popkin 1994; Johns and Maundu 2006; Yang and Keding 2009).

Urban growth, influx from different cultures and growing economic wealth leads to diversification of diets. For example, in Kampala, the demand for a wider range of food products is increasing (Nyapendi et al. 2010). Not only does this mean the 'supermarketization' of foods, or a general growing demand for processed foods, but also fresh food products such as fruits and vegetables. This year-round supply of a diversity of fresh fruits and vegetables is, in theory, a good thing, however many can't afford these products and instead shift to a diet high in calorific staple foods (FAO 2012).

Women and children are especially vulnerable to these urban dietary transitions, and the numbers of overweight and obese women is growing (Mendez et al. 2005). They are at risk of contracting non-communicable diseases such as diabetes and cardiovascular conditions (Popkin 1994; Johns and Maundu 2006; Yang and Keding 2009). Mother and child dietary diversity are associated with one another (Nguyen et al. 2013), and children with poor diets don't develop well. Child malnutrition can be measured through stunting, wasting, or underweight/overweight indicators (WHO 2011).

In rural areas, homegardens have shown to provide increased access to fresh produce and higher intake of fruits (Powell et al. 2015). Studies on specific nutritional contributions (and nutritional quality) are rare (Wilhelm and Smith 2017). Although there are some experiments that indicate improved dietary intake in families with gardens compared to those without gardens (i.e. Kumar and Nair 2004).

In fact, the body of literature studying the associations between (agricultural) biodiversity and dietary diversity is growing (e.g. DeClerck et al. 2011; Remans et al. 2011; Powell et al. 2015; Fungo et al. 2016; M'Kaibi et al. 2016; Romeo et al. 2016). The challenge of feeding nine billion people (Godfray et al. 2010) a healthy diet means that solutions need to be found in a more diversified way and this includes local production.

Kampala has a long history with urban food production (Maxwell and Zziwa 1992) and the associations between urban agriculture and food security have been established at least twice, first by Maxwell et al. (1998) and later by Sebastian et al. (2008). The percentage of total energy consumed from home production by index children was significantly higher among farming household children than in non-farming households (Maxwell et al. 1998; Sebastian et al. 2008). While calorific values are a way of establishing food security, they ignore the lack of essential vitamins and nutrient intake from micronutrient rich food plants, such as fruits.

In the context of urban food production systems, homegardens can provide a valuable source for a variety of foods, and fruits in particular (Chapter 4). Classical[6] urban homegardens are under pressure of high urbanisation rates (Kumar and Nair 2004) .

Dietary supplies from homegardens varies between 3% and 44% (Torquebiau 1992; Kumar and Nair 2004). Although they seldom meet entire food needs, they have the potential to function as a supplementary, much needed, source for specific micronutrient needs. A framework that explains the linkages between urban homegarden agrobiodiversity and potential influence it can have on child nutrition is shown in Figure 5.1.

[6] "Classical homegardens" refers to those gardens found in the homestead and that are described in Chapter 4. The term was adopted from Bernholt et al. (2009), but in this study the term homegarden is simply used.

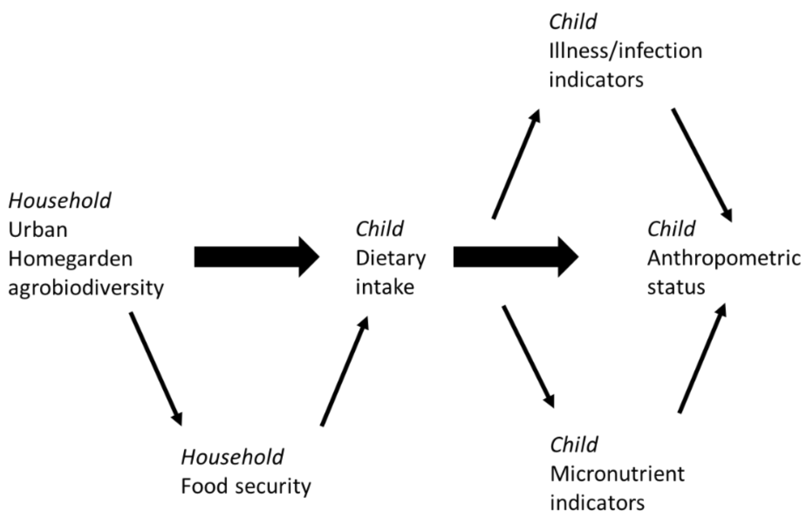

Figure 5.1 Framework of linkages between urban homegarden agrobiodiversity and child nutrition. Adapted from (Yeudall et al. 2008).

5.1.1 Objectives

The Main objective of this paper is to explore determinants of dietary diversity and fruit consumption of children (aged 2-5 years) in Kampala, Uganda.

The sub-objectives of this paper are:

1. To determine nutrition status, dietary diversity and fruit intake of children (aged 2-5 years).
2. To determine the relative contribution from homegardens to overall consumption.
3. To assess whether children with higher garden edible plant richness and diversity have better dietary diversity and fruit consumption.

5.2 Method

5.2.1 Study design and data collection

Data for this study was collected between February and August 2015 in Kampala, Uganda, (Figure 5.2). The city, on the shores of Lake Victoria has an annual bimodal rainfall pattern which averages between 1,750 and 2,000 mm per year and the average temperature is 23 °C (The World Bank 2015).

The target study population for this study was low-income households with at least one index child (aged 2-5 years old), their female caretakers (aged 18-49 years)[7] and who have a homegardens. Households were selected in three urban areas of Kampala inner-, outer-, and peri-urban (KCCA 2012) (Figure 5.2) (see Chapter 4). The aims of this study were explained to the respondent and consent was sought. Upon agreement, the households were visited on three separate occasions.

A structured household questionnaire was conducted covering socio-economic data, such as the number of household members, geographical origin, income sources and assets as well as food-related questions. The wealth index was calculated through a relative poverty calibration using a multidimensional poverty index tool based on multiple poverty indicators such as household assets, housing structures and income sources (Henry et al. 2003). The questionnaires were pre-tested. Field assistants were trained in conducting the survey prior to the visits. They were all native bilingual Ugandans who conducted most of the interviews in the local language Luganda.

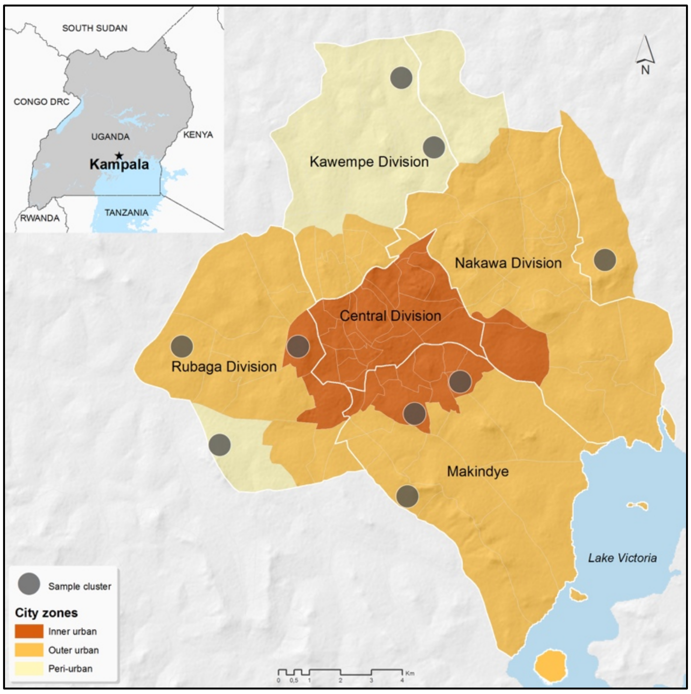

Figure 5.2 Map of Kampala (Uganda) with nine sampling sites indicated with grey dots (source: adapted from (Mollee et al. 2017)).

[7] In Uganda, many children are cared for by their grandparent or another relative. In this study, we refer to the "respondent" as the person who answered the questionnaire (n-49), however due terms "caretaker" or "female caretaker", are used interchangeable and mean the respondent was female aged 18-49 years.

5.2.1.1 Food and dietary Indicators

A repeat 24-hour dietary survey was administered on two non-consecutive days, dietary diversity score (DDS) was calculated for 49 index children (aged 2-5 years old) and 31 main female caretakers in the reproductive age group 18-49 years old (Kennedy et al. 2011). Dietary diversity, and its calculated Dietary Diversity Score (DDS), was based on consumption of nine food groups (Supplement Table 5.7) and functions as a simple proxy indicator for micronutrient adequacy (Arimond et al. 2010). DDS is calculated by counting the number of different food groups a respondent has had a food item from during the 24-hr recall period, and in this study could theoretically range between zero (no food) and nine. The higher the score the more diverse the respondent's diet was. As a second dietary indicator, Food Variety Scores (FVS) were calculated. This also functions as a simple and quick indicator (Steyn et al. 2006) and has as additional benefit that it records the number of unique food items consumed, and thus covers variety within food groups, e.g. did the child eat two bananas (one unique item) or a banana and guava (two unique food items)?

To measure experiences of household food insecurity, we followed the Food and Nutrition Technical Assistance (FANTA) project recommendations and used the household food insecurity access scale (HFIAS) which categorises respondents into four possible scales, from severe food insecurity to high food security (Coates et al. 2007). For a seasonal indication of food insecurity, months of inadequate household food provisioning (MIHFP, range 0-12) were documented, similar to Remans et al. (2011), and adapted from Bilinsky and Swindale (2010).

5.2.1.2 Nutritional status

Child malnutrition was measured through anthropometric measurements to examine the growth indicators of wasting, stunting, underweight and overweight/obesity in the index children. Wasting (low weight for height (WHZ)), stunting (low height for age (HAZ)), underweight (low weight for age (WAZ)) and overweight/obesity levels Z scores were calculated with WHO Anthro, as well as BMI for age (WHO 2011). For the female caretakers only BMI was calculated.

5.2.1.3 Garden agrobiodiversity

As a proxy for garden agrobiodiversity, four separate indicator sets were developed. One consisted of all edible plant species and richness was used as an indicator for overall number of edible plant species in the gardens (Ekesa et al. 2008a; M'Kaibi et al. 2016), the second subset consisted of only those edible plants included that can be included in one of the nine food groups, thus excluding condiments and herbs. The third set only included fruit species, and in addition, a unique food group based indicator was also developed (Romeo et al. 2016), each edible plant species was categorised according to their main food group[8] and individual plants were accumulated, as such livestock and eggs were also included for meat, eggs and dairy (if applicable).

Ecological measures Shannon-Wiener was calculated and used as a diversity indicator for the gardens, as well as Evenness. Since we used subsets of edible plant species in this study, the indices were recalculated from those used in Chapter 4. Moreover, the number of gardens included in this study, was limited to 49 gardens, as those were the only households that included children aged 2-5 years.

5.2.2 Data Analysis

Data analysis was conducted in SPSS (version 22) and R (R Core Team 2016). Correlation analyses (Spearman and Pearson product moment) were conducted between child and female caretaker for DDS, FVS and fruit consumption. Wilcoxon signed rank and t-test were used to test for differences between mean numbers of dietary indicators between child and caretaker.

A binomial Generalised Linear Model (GLM) was applied for a logistic regression to test for selected variables determining child fruit consumption, dietary diversity and food variety (Zuur et al. 2009). All three dietary indicators were transformed into

[8] A different food group structure was used in this study than the one in the previous chapter. In chapter 4 the purpose was to classify food plants into use group, while in this study it is to classify according to nutritional properties.

dummy (binomial) variables, using cut off points for fruit consumption (minimal two fruit types per day), and above mean values for DDS and FVS.

Associations between garden agrobiodiversity and child nutrition (Fruit intake, DDS, FVS) and household food insecurity (HFIAS), were tested with a Pearson and Spearman correlation (Ekesa et al. 2008b).

5.3 Results

5.3.1 Socio-economic characteristics, household food security and anthropometric status of the index children

The mean age of the respondents was 44, with only 19 of the respondents being the biological mother of the index child (Table 5.1). Grandmothers were the largest group in the sample (43%), and only just over half (55%) was married or cohabiting. However, most respondents were female (90%), they had rural backgrounds (74%), and had been living in the city for more than ten years (67%).

Only 10% of the respondents considers themselves food secure. Overall Household Food Insecurity Access Scores (HFIAS) indicated that 72% of the households scored moderate to high food insecurity levels. On average, households reported that about 2.6 months of the year they have inadequate food provisioning. However, the variation between the households was high (0 – 12 months).

Overall the number of stunted or wasted children was very low (Table 5.2). Three children were stunted (HAZ <-2SD) and one severely stunted (HAZ <-3SD). One child was wasted (WHZ <-3SD). More concerning though, was the number of children at risk of being overweight, which were five (WHZ >1SD), and actually overweight, three (WHZ >2Sd). All growth indicators had their mean just below 1 (Table 5.2). There was no variation between the growth indicators (Figure 5.3).

Table 5.1 Profiles of 49 low-income households and the characteristics of the index children in Kampala (Uganda), 2015.

Variables	Overall	Range
Household/respondent profile		
Age of the respondent (years)	44 ± 14.86	18 – 80
Respondent is female (%)	90	
Median garden size (m^2)	591	60 – 2273
Median TLU	0.03	0 – 3.5
Gardens with livestock (% (Obs))	53 (26)	
Origin of the respondent is urban (% (Obs))	12 (6)	
Origin of the respondent is rural (% (Obs))	73.5 (36)	
Time residence >10 years (% (Obs))	67 (33)	
Time farming > 10 Years (% (Obs))	61 (30)	
Main income source is informal business (% (Obs))	78 (38)	
Food expenditure <40k UGSh (% (Obs))	43 (21)	
Respondent is married or cohabiting (% (Obs))	55 (21)	
Mean household size (± s.d. (range))	7.2 ± 2.6	2 – 13
Education level respondent is >upper primary (% (Obs))	43 (21)	
Education level respondent is >lower primary (% (Obs))	84 (41)	
Main ethnicity is Baganda (% (Obs))	82 (40)	
Household food insecurity access scale (HFIAS) (% (Obs))		
Highly food secure	10% (5)	
Mildly food insecure	18% (9)	
Moderately food insecure	35% (17)	
Severely food insecure	37% (18)	
Mean HFIAS score	8.6 ± 5.4	0 - 20
Index child		
Relationship between child and caretaker (% (Obs)):		
Grandmother	43 (21)	
Mother	39 (19)	
Other relative	16 (8)	
Child is a girl (% (Obs))	59 (29)	
Child attends (pre)school (% (Obs))	57 (28)	
Mean Age (months (± s.d.))	42 (± 9.8)	25 - 59
Mean Weight (kg (± s.d.))	14.3 (± 1.9)	10.45 – 19.35
Mean Height (m (± s.d.))	96.2 (± 6.8)	75.5 – 108.8

Table 5.2 Growth indicators of children (n=49) in the sample in Kampala (Uganda) 2015.

Z-scores	**Stunting (Height-for-Age)**		**Underweight (Weight-for-Age)**		**Wasting/Obesity (Weight-for-Height)**		**Wasting/Obesity (BMI-for-Age)**	
	Obs	%	Obs	%	Obs	%	Obs	%
>2	2	4	0	0	2	4	3	6
>1 to 2	4	8	3	6	5	10	6	12
0	26	53	36	74	32	65	32	65
<-1 to -2	13	27	10	20	9	18	7	14
<-2 to -3	3	6	0	0	1	2	0	0
<-3	1	2	0	0	0	0	1	2
Mean	-0.58 ± 1.30		-0.37 ± 0.83		-0.05 ± 1.04		-0.02 ± 1.15	

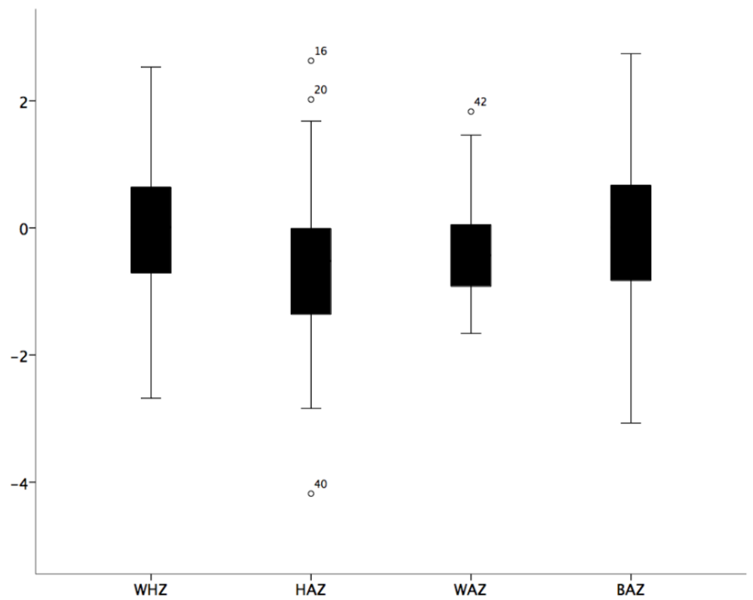

Figure 5.3 Boxplots of anthropometric values of growth indicators of sample of 49 children (aged 2-5 years) in Kampala (Uganda) 2015.

5.3.2 Dietary diversity, food variety and fruit consumption

5.3.2.1 Dietary Diversity and Food Variety Scores

The mean dietary indicators for the index children (n=49) were 4.5 for DDS, 8.5 for FVS and the median fruit consumption of one per day. However, for comparison with their female caretakers, only a subset of the index children were included for comparison (n=31). Women's dietary diversity scores were 4.2 ± 0.79, and 4.6 ± 1.2 for the index child. The lowest DDS measured for the women was DDS = 2.5 food groups, for children DDS= 3. Out of a nine-food based group these numbers are extremely low and indicate very poor nutritional adequacy in some of the households. Mean food variety scores for female caretakers was 8.6 ± 2.0, and 9.4 ± 2.8 for the index children. The maximum consumed number of food groups per individual was higher for index children than for the caretakers (7.5 versus 5.5), this was even more distinct for the food variety scores (12 versus 16.5).

Table 5.3 Results of food and dietary indicators.

Index	**Index child (n = 49)**	**Index child* (n = 31)**	**Caretaker (n = 31)**	**Correlation**	**Test of difference**
Dietary diversity (DDS)	4.5 (3 – 7.5)	4.6 ± 1.2 (3 – 7.5)	4.2 ± 0.8 (2.5 - 5.5)	Spearman rho = 0.861, $P<0.01$	Wilcoxon Signed rank: $P = 0.016$
Food variety (FVS)	8.5 (5 - 16.5)	9.4 ± 2.8 (5 – 16.5)	8.6 ± 2.0 (4.5 – 12)	Pearson R = 0.870, $P<0.01$	T-test: $P = 0.011$
Fruit consumption	1 (0-3)	1 (0 – 3)	0.5 (0-2.5)	Spearman rho = 0.637, $P<0.01$	Wilcoxon Signed rank: $P = 0.008$

*Mann-Whitney U-test shows similar distribution for subset from original set of 49 children for all three indices.

Dietary Diversity Scores (DDS) and Food Variety Scores (FVS) were both highly correlating between child and caretaker (Table 5.3). Similarly, fruit consumption between child and caretaker showed significant correlation. For all three indicators the index child showed higher scores than the caretaker, indicating that the children had higher dietary diversity, food variety and fruit variety than their caretaker. Also, child and caretaker DDS and FVS were correlated as highly significant (Spearman's rho = 0.869, $P<0.01$) and (Spearman's rho = 0.810, $P<0.01$) respectively.

On average, the women included in the sample were overweight (BMI = 27.24 ± 4.89). No correlation was found for nutritional status between child and caretaker (n=28: BMI caretaker vs HAZ (rho=-0.008, p=0.97), BAZ (r=0.262, df=26, p=0.179), WHZ (r=0.265, df=26, p=0.174), and WAZ (r=0.178, df=26, p=0.422)).

5.3.2.2 Food sources

Most food items were purchased, either from markets (62%), or from neighbours and friends (29%). Homegardens provided 5% of the total amount of food items consumed by the index children (Figure 5.4). In this study, only very little came from the village (0.15%), and 4% were gifted by neighbours, friends or relatives.

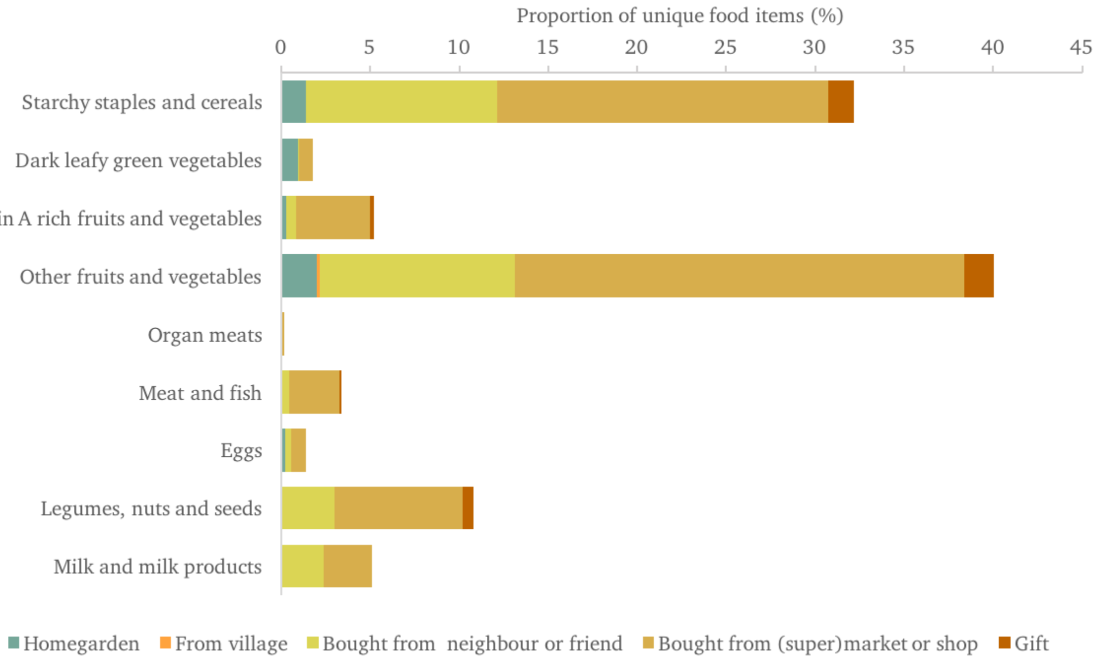

Figure 5.4 Proportion of food groups and their sources of the unique food items consumed by the 49 children during the repeat 24-hour recall in Kampala (Uganda) 2015.

5.3.2.3 Fruit consumption

Overall, 78% of the children (n=49) was reported to have consumed at least one type of fruit during the two-day survey period, 53% had at least one type of fruit each day, and 18% had two types of fruit. Passionfruit (39%) was the most frequently consumed fruit type by the children (Table 5.4). This was usually served as juice prepared by the caretaker. The second most frequently consumed fruit was banana (35%) and then avocado (22%) and mango (18%).

For the caretaker (n=31), 84% reported to have had at least one type of fruit over the two day survey period, 48% had at least one type of fruit each day and 10% had two types of fruit. The most frequently consumed fruit was avocado (48%), followed by passionfruit and mango (both 19%) and orange (16%). Among the least frequently consumed fruits was the only indigenous fruit captured by the survey, Spanish tamarind, or *Vangueria apiculata*.

Table 5.4 Diversity of fruit intake by children and their caretakers recorded during the repeat 24-hour (equal to two days) recall for each day separately. Overall frequency and observation refers to the number of individual children that consumed the specific fruit at least once during the two-day recall.

Fruit type	**Index child (n=49)**						**Caretaker (n=31)**					
	Day 1		Day 2		Overall		Day 1		Day 2		Overall	
	Freq (%)	Obs	Freq (%)	Obs	Freq (%)	Obs	Freq (%)	Obs	Freq (%)	Obs	Freq (%)	Obs
Passionfruit	27	13	24	12	39	19	19	6	6	2	19	6
Banana	24	12	12	6	35	17	13	4	3	1	13	4
Avocado	6	3	18	9	22	11	19	6	39	12	48	15
Mango	14	7	12	6	18	9	6	2	16	5	19	6
Orange	8	4	4	2	12	6	13	4	3	1	16	5
Jackfruit	6	3	6	3	10	5	13	4	3	1	13	4
Guava	6	3	4	2	8	4	0	0	0	0	0	0
Papaya	2	1	4	2	6	3	0	0	6	2	6	2
Pineapple	6	3	0	0	6	3	3	1	0	0	3	1
Watermelon	2	1	2	1	4	2	0	0	0	0	0	0
Apple	2	1	0	0	2	1	0	0	3	1	3	1
Pear	2	1	0	0	2	1	0	0	0	0	0	0
Starfruit	0	1	2	1	2	1	0	0	0	0	0	0
Tangerine	2	1	2	1	2	1	0	0	0	0	0	0
Spanish tamarind	2	1	0	0	2	1	0	0	0	0	0	0

5.3.3 Garden diversity

The total number of edible plant species found in the 49 households were 70 species, of which 25 were fruit species and 19 vegetables. More specifically the food plants covered nine food groups: *Starchy staples, cereals and plantains* (10 species); *Dark green leafy vegetables* (7 species); *Vitamin A rich fruit and vegetables* (9 species); *Other fruits and vegetables* (27 species); *Legumes, nuts and seeds* (3 species); *Spices and condiments* (12 species); *High sugar foods* (1 species); *Fats and oils* (1 species)[9].

Not all species were ready for harvest during time of the inventory, but since they are present in the garden they are considered potential edible species.

Average garden richness of edible plant species was 15, 13 for edible plant species that contribute to a nine food group diet and six for fruit species only (Table 5.5). Plant species richness ranged between the households, for example edible species ranged from seven to 31. Shannon diversity index for all edible plants was 1.99, for food group plants only 1.83 and fruits plants only 1.48.

Table 5.5 Agrobiodiversity indicators: richness, density, diversity and evenness of food crops in the gardens

Indicator	(sub)group	Mean ± s.d.*	Range
Richness (n=49)	All edible species	15.00	7 - 31
	Food group plants only	13.00	5 - 28
	Food groups incl. livestock	6.00	3 - 8
	Fruits	6.00	1 - 12
Density (n=48)	All edible species	199	32 - 3621
	Food group plants only	190	29 - 3405
	Food groups incl. livestock	222	29 - 3409
	Fruits	32	4 - 130
Shannon (n=49)	All edible species	1.99 ± 0.47	0.66 – 2.83
	Food group plants only	1.83 ± 0.44	0.59 – 2.64
	Food groups incl. livestock	1.15	0.21 – 1.85
	Fruits	1.48	0.00 – 2.22
Evenness (n=46)	All edible species	0.79	0.23 – 0.91
	Food group plants only	0.77	0.21 – 0.91
	Food groups incl. livestock	0.73	0.15 – 0.95
	Fruits	0.89	0.52 – 0.99

*s.d. for parametric distributions only, otherwise median is presented. One garden was removed for density calculation because of extreme counts of certain crops. Sample size for evenness calculation was lower due to missing values.

[9] For full list of species see chapter 4.

5.3.4 Associations between determinants of fruit consumption, dietary diversity and food variety

Results of a logistic regression analyses indicate that children from wealthier households are more likely to have higher fruit intake and higher overall dietary diversity ($p < 0.05$; Table 5.6). The model did not indicate which determinants increase the likelihood of higher food variety, although wealth is close to significant at $p = 0.083$. Children from households where the respondent was married or cohabited with a partner were also more likely to have higher fruit intake.

Table 5.6 Results of a logistic regression analysis for child fruit consumption, dietary diversity score (DDS) and food variety score (FVS) for 49 children in Kampala (Uganda), 2015.

Variables	**Fruit ≥ 2**		**DDS ≥ 4.5**		**FVS ≥ 8.5**	
	Estimate	*P* value	Estimate	*P* value	Estimate	*P* value
Wealth score (MPI)	2.4908 (0.9826)	0.011*	1.6789 (0.6224)	0.007**	0.7431 (0.4374)	0.083
Respondent is married or cohabiting	5.6348 (2.5454)	0.027*	-0.4604 (0.8431)	0.585	0.2295 (0.7387)	0.756
Origin respondent is urban	0.7250 (8.7521)	0.934	-1.5890 (1.3851)	0.251	-0.7725 (1.1813)	0.513
Food expenditure <40k UGSh	-0.5897 (1.1259)	0.601	-1.2017 (0.7625)	0.115	-0.1267 (0.6782)	0.852
Household size	-0.1717 (0.2282)	0.452	-0.1900 (0.1601)	0.235	-0.1155 (0.1384)	0.404
Education level respondent is >lower primary	2.7413 (2.7788)	0.324	0.4042 (1.0101)	0.689	0.5661 (0.7808)	0.469
Constant	-7.8697 (4.5373)	0.082	2.1909 (1.4219)	0.123	0.7857 (1.1208)	0.483

Standard errors in parentheses.

In this study no significant associations were found between garden agrobiodiversity and DDS, FVS and fruit consumption during the dry post-harvest months. Nor could we find a link between garden diversity and HFIAS during this season.

5.4 Discussion

5.4.1 Dietary diversity, food variety and fruit consumption

Overall fruit consumption was low for index children and caretakers. Even though 78% of the children and 84% of the caretakers reported at least one type of fruit during the two-day recall, it is not sufficient to meet the daily recommended allowance of two fruits per day. Only 18% of the children and 10% of the caretakers reported these numbers.

There is no predefined cut off points for dietary diversity scores based on the nine food groups. However based on the results in our study indicates a low (DDS = 1-3) to medium (DDS = 4-6) and high (DDS = 7-9) distribution (Keding et al. 2012). Mean dietary diversity was of medium quality for most respondents. The food variety scores indicate a similar trend.

Various factors are known to improve child nutritional status: education level and age of the mother (IFPRI 2016). However, in this study they were not found as significant determinants of fruit intake and dietary diversity. The main determining factor in this study that predicted child fruit intake and DDS was wealth score. These findings were similar to Sebastian et al. (2008) who found that the main elements of urban agriculture that affect household food security are *wealth*, *land size*, *livestock keeping*, *gender* and *education*.

This study furthermore confirmed the relationship between caretaker and child nutrition (Nguyen et al. 2013).

5.4.2 Contribution of different sources

For the children included in this study, 5% of their food items came directly from their own homegarden, of which most can be categorised as fruits and vegetables. While 5% may appear to be a small proportion to some, it falls within the range mentioned in the literature of between 3% and 44% (Torquebiau 1992; Hoogerbrugge and Fresco 1993; Kumar and Nair 2004).

However, an additional 4% was gifted by neighbours and friends and these could have been sourced from a neighbouring garden who just had a tree fruiting for example. Generally this type of sharing occurs in close communities. In fact, the findings in this study indicate that people's social networks play an important role in the source of food products. Most of the foods were bought at commercial markets (62%), while a notable

29% was purchased from neighbours and friends. It was beyond the aims of this study to explore the exact sources of those products, however hypothesising about these sources is not. Most of these products are staples, fruits and vegetables, which could indicate urban production, which would then mean that the contribution of urban production to households' diets is potentially higher than the 5% directly reported by the households interviewed.

Even though no significant link could be found between garden diversity and child nutrition, it should not be underestimated. The links between homegardens, increased fruit consumption and dietary diversity has presented mixed outcomes in the literature (Remans et al. 2011; Poulsen et al. 2015; Warren et al. 2015). While fruit consumption might be higher in households with rich homegardens, few studies have demonstrated links with anthropometric measures of nutritional status (Powell et al. 2015). However, despite no link being identified between nutritional status of children and dietary intake, this does not mean it is absent. The outcome of this study may be due to inadequate sample size and other issues with study design (Ruel 2003; Ruel and Alderman 2013). The sample size was rather small, and detecting specific micronutrient deficiencies is not possible through anthropometric measurements. However, providing statements which nutrients or minerals are lacking is not within the scope of this study. Another limitation within this study is the absence of a seasonal study, which has shown to be of effect in other studies (Mayanja et al. 2015).

Moreover, stunting levels in this sample can be considered low with 'only' 8% of the children indicating chronic malnutrition compared to 30% nationally and 24% in urban areas (UBOS and ICF 2017). This could indicate that children from households with homegardens have better nutritional status than children from households who lack access to these sources. However, a separate study comparing children who have access to gardens to those who do not, would be recommended.

5.4.3 Contributions from a biodiverse landscape

Using ecological approaches to study nutrition, has been receiving more attention. The search for more sustainable ways which incorporate healthy diets and productive ecosystems requires holistic and transdisciplinary thinking (DeClerck et al. 2011; Remans et al. 2011), such as nutrition sensitive urban agriculture (Gerster-Bentaya 2013).

Even though yield estimates are an important factor to determine nutritional outputs in quantity (as well as for income calculations), they are notoriously difficult to measure. Since the aim of this study was dietary intake rather than yield, tracing food items consumed back to the source appears to be a much more efficient method to determine links between diets and gardens.

The findings in this study suggest that having access to homegardens can play an important role in reducing levels of child stunting. However, homegardens aren't accessible to everyone. A more in-depth comparison between dietary diversity, food variety as well as specific fruit and vegetable consumption between children with and without access to homegardens would provide better insight into which crops are key in providing these minerals and (micro)nutrients. Then programmes can be developed to provide nutrient rich crops to at risk households through for example community and school gardens in a more efficient way. This would then reduce the risk of child stunting and even obesity.

5.5 Conclusion

Comparisons with secondary data suggests that the children included in this study have better nutritional status then urban children in Uganda overall. This could indicate that children with access to homegardens have better nutritional status, even though this study provided no direct evidence that higher garden agrobiodiversity improves dietary diversity and nutritional status of children during the fieldwork season. However, 5% of their dietary intake was derived from homegardens and a further 4% gifted, and most notably 29% was bought from friends and neighbours. This could indicate that consumption from products produced in the urban landscape is potentially much higher than the 5% directly from the gardens. The role that homegardens play in the contributions of more nutritionally diverse diets are important findings that can move both science as well as the development field into more integrated directions. To ensure a more food secure city, researchers, policy makers and urban planners need to become aware of the potential of these urban homegardens and incorporate them in future urban development plans.

Supplement

Table 5.7 List of the unique dietary items within 9 food groups according to Kennedy et al. (2011) observed during a repeat 24-hour recall in Kampala (Uganda) 2015.

No	Food group	Foods within group
1	Starchy staples	Cereals: Maize (posho, popcorn, cob), rice, oats, wheat (bread, pasta, porridge), millet, sorghum. White roots and tubers: Cassava, yams (cocoyams and other), plantains, potatoes and sweet potatoes
2	Dark green leafy vegetables	Amaranth species (incl. *doodo*), carrot greens, *nakati*, spinach, S*ukuma wiki*
3	Other Vitamin A rich fruits and vegetables	Fruits: mango (ripe), papaya, passion fruit. Vegetables: Carrots, pumpkin.
4	Other fruits and vegetables	Fruits: Apple, avocado, banana, guava, jackfruit, lemon, mango (green), orange, pear, pineapple, starfruit, tangerine, *tugunda,* watermelon. Vegetables: African eggplant, Cabbage, eggplant, garlic, green pepper, onion, onion leaves, tomato, Uganda pea eggplant/bitter berries (*Katunkuma).*
5	Organ meat	Intestines, liver, offals
6	Meat and fish	Beef, chicken, pork, dried fish, fresh fish (*mamba, mputa, machine, tilapia*)
7	Eggs	Chicken eggs
8	Legumes, nuts and seeds	Beans (dry and fresh), cow peas, groundnuts (normal and flat big one), peas, soy beans (flour)
9	Milk and milk products	Milk (fresh and powdered)

6 Into the urban wild: Collection of wild urban plants for food and medicine in Kampala, Uganda[10]

Abstract

In sub-Saharan Africa, many people depend on natural resources for their livelihoods. While urbanisation causes landscape changes, little is known of how this process affects the use of wild plant resources by urban populations. This study contributes to addressing this knowledge gap by exploring the prevalence and determinants of urban collectors of wild plants in Kampala, Uganda. During February to August 2015, 93 structured interviews were conducted in inner, outer, and peri-urban areas of the city. The findings in this study show that urban wild plants are used by almost half (47%) of the respondents, mainly for medicinal purposes but also as a complement to diets. The findings further indicate that residents with lower income, of younger age (<51 years old), and predominantly living in peri-urban areas are more likely to be urban collectors. Seasonality appears to be of greater importance in collection of food plants than of medicinal plants. Overall, these findings indicate that wild plants occupy an important role in the livelihoods and traditions of Kampala's residents, and we argue that this should be taken into account in urban planning projects.

Keywords: Livelihoods, natural resource management, non-timber forest products, safety net, urban ecosystems, human ecology

[10] Mollee EM, Pouliot M and McDonald M. (2017). *Into the urban wild: Collection of wild urban plants for food and medicine in Kampala, Uganda.* Land Use Policy 63: 67-77.

6.1 Introduction

Urban collection of wild plants is a subject that has received scant attention in studies of natural resource usage and conservation. There is therefore very little understanding of its prevalence and determinants. However, the body of evidence on the importance of wild plants in rural peoples livelihoods in developing countries is growing, and it is recognised that non-cultivated plants are highly valued as a strategy to combat food insecurity, dietary deficiencies (Arnold et al. 2011; Powell et al. 2011; Mahapatra and Panda 2012; Vinceti et al. 2013) and alleviate poverty (Sunderland and Ndoye 2004; Oteng-Yeboah et al. 2011; Shackleton et al. 2011b). They also play an important role in maintaining and improving health in different settings (e.g. (Pouliot 2011; McMullin et al. 2012)).

African countries have some of the highest urbanisation rates and it is estimated that 50% of Africa's population will be living in urban areas by 2030 (Montgomery 2008; The World Bank 2015). In a region that is already severely affected by demographic, political and economic challenges, urban development plans need rethinking to accommodate the population in a sustainable way (UN Habitat 2014). Effects of climate change and the rise of unplanned informal settlements cause pressure on urban natural vegetation (Cohen 2006; The World Bank 2015). Thus, urbanisation affects local biodiversity (McKinney 2008), directly through land cover change, or indirectly by changing ecosystem and biogeochemical processes (Alberti 2008).

Along with loss of local biodiversity comes a change in the use of wild plant resources. This is frequently seen as erosion of traditional knowledge and has been assumed to be particularly prevalent in the urban environment, where global influences, market availability of exotic species and loss of biodiversity pose a threat to traditional knowledge systems (Vandebroek et al. 2011; Sogbohossou et al. 2015). Nevertheless, market studies show that the interest in wild plant species does not disappear as people move from rural to urban areas (e.g. (Bariregа et al. 2012; McMullin et al. 2012; van Andel et al. 2012; Vandebroek and Balick 2012; Sneyd 2013)). Household studies on urban consumption of wild plants, however, are much rarer. Still, the scant evidence on the topic can provide some insights into consumer profiles and their underlying motivations for consuming wild plants, as well as provide information on the state of traditional knowledge of urban residents (Oreagba et al. 2011; Schlesinger et al. 2015). For example, a study conducted in Suriname in 2006 (van Andel and Carvalheiro 2013) showed that 66% of the urban population use wild medicinal plants (mostly self-collected in their own garden or neighbourhood) and that its consumption is neither linked to poverty nor to limited access to allopathic healthcare. Health status and traditional knowledge are instead the strongest explanatory variables of medicinal plant consumption in the urban study area. Qualitative evidence from Yaoundé, Cameroon, shows that wild food plants are important ingredients for the preparation of commonly-prepared traditional dishes (Sneyd 2013).

These studies demonstrate that the use of wild plants still play important roles in the lives of urban residents, but say little about sources of these plants. In fact, only a few authors discuss sources of wild plants outside of markets such as wild collection. While wild collection of plant species in rural communities has been studied extensively (e.g. (Cunningham 2001; Pouliot 2011; Tabuti and van Damme 2012; Vinceti et al. 2013)), there is only very little empirical evidence showing that urban collection of wild species occurs (e.g. Davenport et al. 2011; McLain et al. 2013; Kaoma and Shackleton 2014; Schlesinger et al. 2015; Furukawa et al. 2016). Yet, urban collection can be considered a "deeply relational practice connecting humans with nature, other humans and their inner selves" (McLain et al. 2013, p. 12). Moreover it is a form of preserving cultural identity, it provides free medicines and adds to food security as a safety net preventing people from falling deeper into poverty in times of hardship (e.g. unexpected shocks and crises) (Davenport et al. 2011). In an urbanising world, where traditional knowledge systems and biodiversity are threatened, this is a field that deserves more attention (Penafiel et al. 2011; Sneyd 2013).

Studies conducted in Southern Africa by Davenport (2011), Kaoma (2014) and Schlesinger (2015) all focused on the use of wild natural resources in medium sized towns and cities (Davenport et al. 2011; Kaoma and Shackleton 2014; Schlesinger et al. 2015). These locations are all fast growing and important because there are still opportunities for planning interventions. The findings of Davenport et al. (2011) indicate that town size determines the intensity of wild plant collection practices, as they found 27% of the population in larger towns versus 70% in smaller towns to be urban collectors (Davenport et al. 2011). However Schlesinger et al. (2015) did not find any relationship between size of town and prevalence of wild plant collection in urban areas (Schlesinger et al., 2015). Instead, they found that the importance of urban collection of wild plants is related to the location of the household in the urban to peri-urban continuum; they attribute this to the higher share of land covered by vegetation in peri-urban areas. As these peri-urban areas are prone to near-future developments and urbanization, their role in local livelihoods needs to be understood before unsustainable and (un)planned development ensues (Davenport et al. 2012; Vermeiren et al. 2013).

While the use of wild plants still has an important role in peoples' livelihoods through traditional medicines and food culture, it is important to understand where in the urban and peri-urban environment wild plant collection takes place in order for public policy to incorporate the land use practice in its designs, including the food security agenda. In addition to understanding the characteristics of urban collection - the who, where and when – it is important to understand how collection of wild plants is perceived, as public perception can be an important determining factor (Tabuti and van Damme 2012). For example, if collection of wild plants is a socially accepted practice, it can form a driver in conducting the practice, while a negative view may inhibit people to collect wild plants, at least in plain sight. Understanding these subtleties can immensely improve effective policy design (Walker et al. 2013).

This paper aims to explore the scope of collection of wild plants in Kampala, Uganda. Moreover, it investigates the determinants associated with the collection of wild plant species in an urban context. This study aims to answer 5 research questions:

- What characterises collectors of wild urban plants?
- Which plants are collected and for what use?
- Where and in what type of locations (public or private) does urban collection take place in the urban and peri-urban environment?
- Does urban collection of wild plants function as a safety net?
- What are people's attitudes and perceptions regarding urban collection?

6.2 Methods

6.2.1 Definition of concepts

Three words can be used to describe the concept we discuss: collecting, gathering and foraging. In this paper we use the term "urban collection", however different authors have used various concepts that have similar definitions, such as "urban gathering" or "urban foraging" (of which the latter implies collection of food products) (McLain et al. 2013) and "the use of urban commons" or "commonages" (which is a broader concept and refers to lands available to the public, including everything that grows on it) (Davenport et al. 2011).

Wild plants grow within a spectrum of human involvement (Wiersum 1997; Cruz-Garcia and Price 2014). The plants grow on vacant lots and on roadsides as well as landscaped areas such as parks and gardens. They are mainly wild, non-altered species, but also include "feral" cultivars. Feral plants are those that have grown without any human intervention, and can include plants that are technically cultivars but were not intentionally planted (McLain et al. 2013). This phenomenon is quite common in urban areas, where high levels of organic waste causes cultivars to take root and grow into productive plants. More specifically, in the context of our study we focus on plants used for food and/or medicine within these urban landscapes and refer to the practice as urban collection of wild plants. We further specified our definition for wild plants included in this study as plants that: (1) can come from any part of the landscape other than the respondent's own garden, and (2) have minimal to no involvement of human management such as cultivation or pruning etc. by the collector.

Attitude and perception are closely related concepts, that are dynamic in time and can influence each other and their behavioural outputs. While attitude is "a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour", perception can be understood as "a process of interpretation by which individuals ascribe meaning to things" (Eagly and Chaiken 1993). We use both these concepts to interpret how the respondents regard urban collection.

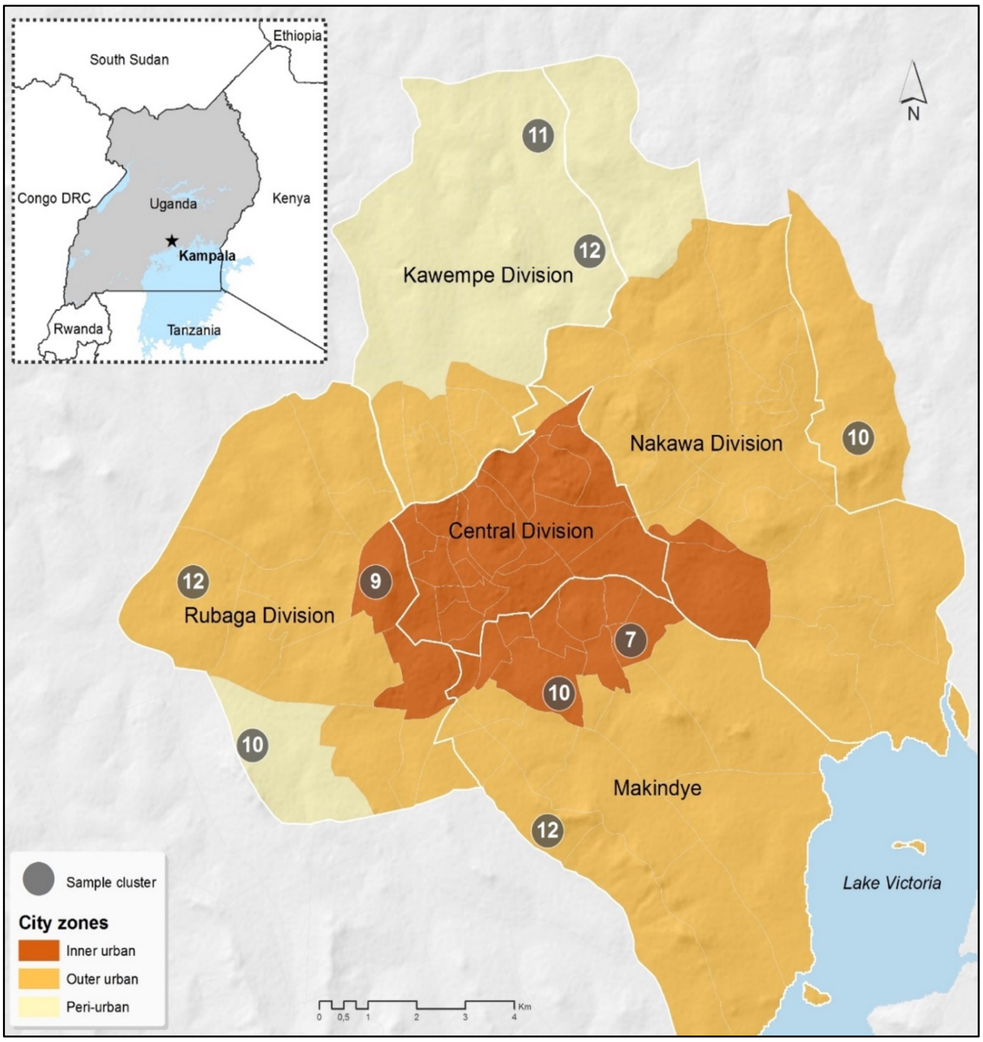

Figure 6.1 Map of Kampala, Uganda with inner-, outer- and peri-urban areas indicated. The nine cluster sampling sites are indicated with the grey dots. The numbers within the dots show the number of households included in this study at each cluster site.

6.2.2 Study area and population

Data collection for this study took place in Kampala, Uganda between February and August 2015 (0°19'N, 32°35'E) (Figure 6.1). Over the past three decades, Kampala has experienced an annual growth rate of about 4% to its current population level of almost 1.9 million inhabitants (CIA 2016). This has caused the city to increase the total built-up area from 71 km2 to 386 km2 (Vermeiren et al. 2012) and hence led to the disappearance of much of the city's green areas (Vermeiren et al. 2013).

6.2.3 Sampling and Data Collection

Since this study was part of a larger project that focuses on child nutrition and urban plant diversity, the target study population for this paper are low-income urban homegarden-farming households with at least one child (2-5 years old). Three residential area typologies (inner-, outer- and peri-urban) were derived from classifications by Kampala Capital City Authority physical development plan (KCCA 2012). These classifications were based on location and proximity to the city as well as population density. Next, a two-staged cluster sampling was applied. Within each area, three parishes (clusters) were selected based on the following criteria: residential area characteristics, homegarden pervasiveness and lower level income neighbourhoods. The inner urban areas included Namirembe, Kabalagala and Nsambya/Lukuli with an average population density of 301 people per hectare, the outer urban parishes included Busega, Kireka and Luwafu with an average population density of 115 people per hectare, and lastly, with an average of 60 people per hectare, Kyanja, Kikaya, and Mutundwe were included from the peri-urban area (UBOS 2014). Within each parish, 9 to 13 households were then purposively selected based on the presence of a homegarden, a child and an available respondent. The aims of our study were explained to respondent and consent was sought.

Overall, 93 households were included in this study. The households who agreed to take part were visited twice. The first visit covered general household information through structured questionnaires, such as the number of household members, geographical origin of household members, and income sources and assets, while the second visit focused on species collected by the household during the six months prior to the interview (6 month recall period), and included questions about attitudes and perceptions of the use and collection of wild plants. Due to the ambiguity in recall studies (i.e. (Jagger et al. 2012)), a 6 month recall period was preferred because it is considered more reliable than a 1 year recall period, yet still captured both a wet and a dry season. Both questionnaires were pretested and the interviewers were trained in conducting the survey prior to the visits. They were all native bilingual Ugandans who were able to conduct the interviews in the local language, Luganda. Additional data collected were GPS coordinates and residential (homestead) plot size.

An adapted free listing technique was used for recollection of collection activities (Weller and Romney 1988) and in addition the respondent was guided by resource categories to help them remember the wild plants collected (Cavendish 2002). Information on the use of wild plants, purpose (private or commercial), source, month(s) and frequency of collection was recorded. Only the primary use of a species was recorded.

A Multidimensional Poverty Index tool (Henry et al. 2003) was used to calibrate relative poverty within the sample group by conducting a principal component analysis (PCA) on multiple poverty indicators such as household assets, housing structures and income sources. Household food insecurity was determined with the Household Food Insecurity Access Scale (HFIAS) (Coates et al. 2007), which is an approach to measure experiences of household food insecurity through survey questions which is summarised in four scales, from severe food insecurity to high food security.

6.2.4 Model and Analysis

We used a binomial Generalized Linear Model (GLM) to determine whether respondent and household variables have any predictive value over a respondent's decision to collect wild plant species (Table 6.1). More specifically we used the Probit model, which is a special link function in the GLM. We used logistic regressions to find out whether the amount of land owned had an effect on the location of wild food collection (i.e. private or public land).

The Probit regression analysis as well as other descriptive statistical analyses were conducted with STATA/13.

Table 6.1 Description and expected influence of independent variables and household attributes used in the analyses.

Variable	Expected influence on the frequency of wild plan collection activities
Sex of the respondent	Women collect more wild plants than men as they traditionally are the main collectors of wild plants in Uganda (Agea et al. 2011b; Barirega et al. 2012; Ojelel and Kakudidi 2015).
Elder respondent (above 50)	Elderly people collect more plants as they have more time and knowledge of useful wild plants than younger people (Tabuti and van Damme 2012; Ojelel and Kakudidi 2015; Tugume et al. 2016).
Education	People with a higher education level are more likely to choose allopathic health services (Pouliot 2011), and are thus less likely to collect plants from the wild for medicinal use. In South Africa, low levels of education was significantly correlated with wild plant collection in two out of three towns studied (Davenport et al. 2011).
Wealth status	Lower income households are more dependent on wild plant resources for (subsistence) income (Shackleton et al. 2011b; Jagger 2012; Kaoma and Shackleton 2015) which can potentially help mitigate urban poverty (Davenport et al. 2011), whilst wealthier households that are part of a more formal economy have better access to markets to buy commodities such as food and medicine due to higher cash income. They have more choice in types of food and medicine, and, according to a study in Uganda, prefer allopathic medicine above traditional medicinal plants (Tabuti et al. 2003b).
Household food insecurity	Households that are more food insecure feel a higher need to collect from the wild to complement their diet (Kaoma and Shackleton 2014).
Household size	Larger households tend to be poorer and are therefore more likely to feel the need to collect wild plants (Ssewanyana 2009). They also have higher labour availability, which they can use to collect wild plants.
Urban or rural background respondent	Collection of wild plants is more common in rural areas than in urban areas (Davenport et al. 2011; Kaoma and Shackleton 2014). People with rural backgrounds are therefore more likely to possess traditional knowledge of wild plants (Tabuti and van Damme 2012) and will be more inclined to collect wild plants in the urban landscape.
Location in Kampala	Peri-urban areas are less densely populated and more abundant in wild plants than inner urban areas (Schlesinger et al. 2015).
Plot size household	Larger gardens (plots) lead to more food security (Mwangi 1995), hence reduces the need for wild plant collection.

6.3 Results

Table 6.2 Characteristics of households and urban collectors included in the study.

Variables	**All households interviewed (n=93)**		**Urban collectors (n=44)**	
	Continuous variables	**Categorical variables**	**Continuous variables**	**Categorical variables**
	Mean ± S.D.	**Obs[(a)] (%n)**	**Mean ± S.D.**	**Obs[(a)] (%n)**
Sex				
Female		81 (87%)		38 (86%)
Male		12 (13%)		6 (14%)
Elder respondent (above 50)		25 (27%)		4 (9%)
Education				
No formal schooling		6 (6%)		4 (9%)
Lower primary		8 (9%)		4 (9%)
Upper primary		30 (32%)		15 (34%)
Secondary O level		29 (31%)		13 (30%)
Secondary A level		7 (8%)		1 (2%)
Vocational school		4 (4%)		3 (7%)
Tertiary		4 (4%)		2 (5%)
University		5 (5%)		2 (5%)
Wealth status				
Poorest		23 (25%)		15 (34%)
Below average		23 (25%)		14 (32%)
Just above average		22 (24%)		3 (7%)
Highest wealth status in sampling group		23 (25%)		10 (23%)
Household Food Insecurity Access Scale				
Highly food secure		11 (12%)		6 (14%)
Mildly food insecure		24 (26%)		9 (20%)
Moderately food insecure		26 (28%)		12 (27%)
Severely food insecure		32 (34%)		17 (39%)
Household size	6.9 ±3.1		6.8 ±2.8	
Urban or rural background respondent				
Rural		67 (72%)		32 (73%)
Urban		15 (16%)		7 (16%)
Semi/peri urban		11 (12%)		5 (11%)
Location in Kampala				
Inner		26 (28%)		11 (25%)
Outer		34 (37%)		12 (27%)
Peri-urban		33 (35%)		21 (48%)
Plot size household[(b)]	0.104 ±0.077		0.099 ±0.089	

[(a)]Obs = number of observations
[(b)] Household plot size was measured in hectares and included built structures.

6.3.1 Characterisation of urban collectors

In total, 44 of the 93 respondents (47%) reported collecting wild plants in urban areas during the six months covered by the survey period (Table 6.2). The results show that respondents under the age of 51 as well as respondents with a lower household income are more likely to report collecting wild plants in Kampala than other households (Table 6.3).

Table 6.3 Probit results of determinants of urban collection of wild plants in Kampala, Uganda

Variables	**Coefficient**	***P*-value**
Respondent is female	0.012	0.980
Resident in inner Kampala	0.533	0.172
Elder respondent (above 50)	-1.654	**0.000**
Education level of respondent (in years)	-0.082	0.389
Wealth index score	-0.372	**0.018**
HFIAS category	-0.149	0.401
Household size (number of people)	-0.012	0.811
Household has migrated from a rural area	0.186	0.570
Resident in Peri Urban area	0.818	**0.022**
Size of household plots (ha)	-0.127	0.948
Constant	0.431	0.631

LR χ^2 (11) = 28.38

Prob > χ^2 = 0.0016

Pseudo R^2 = 0.2228

6.3.2 Species collected

A total of 48 plant species (from 25 families) were recorded (Table 6.4). Of these plants 52% are collected for medicinal uses and 48% for food (12 fruit species, 3 leafy green vegetables, 1 other vegetables, 3 condiments (spices and teas), 3 types of pulses and 1 cereal). The plants originated from naturally generated populations (‘wild’ – this was mainly the case of medicinal herbs) or were ‘feral’ cultivar plants; the latter were plants which had taken root from organic waste or in some cases (mainly fruit trees and shrubs) had previously been planted but were abandoned or managed by neighbours (Table 6.4). Among the urban collectors, 10 collected only food plants, 20 collected only medicinal plants, and 14 respondents collected both food and medicinal plants. Moreover, 63% of all plant collection events reported are for medicinal use, and 37% for food. This study could not identify any factors determining whether a household collects food or medicinal plants.

Overall 50% of the plant species are considered indigenous and 50% exotic. Food plants collected include the more common fruit tree species such as jackfruit (*Artocarpus heterophylus* Lam.), guave (*Psidium guajava* L.), mango (*Mangifera indica* L.) and avocado (*Persea americana* Mill.), but also indigenous fruit species such as Madagascar cardamom (*Aframomum angustifolium* (Sonn.) K.Schum.) and Spanish tamarind (*Vangueria apiculata* K.Schum). Fruit species were mentioned more often than leafy green vegetables, even though the leafy green vegetable *Amaranthus dubius* Mart. Ex Thell. was mentioned by eight respondents and has the highest citation rate for food species in this study.

The most cited medicinal plant species are *Momordica foetida* Schumach. *Vernonia amygdalina* Delile, *Hoslundia opposita* Vahl, black Jack (*Bidens pilosa* L.), aloe (*Aloe Vera* (L.) Burm.f.) and little ironweed (*Cyanthillium cinereum* (L.) H.Rob), and can all be considered indigenous or naturalized.

The mean number of plant species collected per household was 2.5 (s.d. ±1.5) and ranged between 1 and 8. All plants were collected for own use only, which means that none of them were collected for marketing purposes.

6.3.3 Collection locations

In total, 41% of the respondents who reported collecting urban wild plants did so on private land only, 39% collected only from public land, and 16% collected both from public and private land (and 5% of the respondents declined to name the source or didn't know). Results of a logistic regression show households owning larger parcels of land are more likely to practice urban collection only on private land (p-value=0.080) and less likely to collect on public land (p-value=0.018). Location of residence also influences the source of wild plants collected: people residing in peri-urban areas are more likely to collect only from public lands than other households (p-value=0.018) and people residing in inner Kampala are more likely to collect from private land only (p-value=0.080).

Table 6.4 Wild plant species collected in Kampala by respondents (species are sorted by frequency of response).

Botanical family	Botanical name	Vernacular names[(a)]	Use[(b)]	Total collection citations	Indigenous/ Exotic[(c)]	Wild type[(d)]
Cucurbitaceae	*Momordica foetida* Schumach.	Bbombo (Lu)	M	14	I	F/W
Asteraceae	*Vernonia amygdalina* Delile	Mululuuza (Lu)	M	11	I	F/W
Amaranthaceae	*Amaranthus dubius* Mart. Ex Thell.	Doodo (Lu)	F	8	E	F/W
Lamiaceae	*Hoslundia opposita* Vahl	Kamunye (Lu)	M	8	I	F/W
Asteraceae	*Bidens pilosa* L.	Black Jack (En), Ssere (Lu)	M	6	E	W
Asteraceae	*Cyanthillium cinereum* (L.) H.Rob.	Little ironweed (En), Kayayaana (Lu)	M	4	I	F/W
Moraceae	*Artocarpus heterophylus* Lam.	Jackfruit (En), Ffene (Lu)	F	4	E	F
Xanthorrhoeaceae	*Aloe Vera* (L.) Burm.f.	Aloe (En), Kigagi (Lu)	M	4	E	F/W
Amaranthaceae	*Chenopodium opulifolium* Schrad. Ex W.D.J.Koch & Ziz	Mwetango (Lu)	M	3	I	W
Myrtaceae	*Psidium guajava* L.	Guava (En), Ppeera (Lu)	F	3	E	F
Amaranthaceae	*Aerva lanata* (L.) Juss.	Lweza (Lu)	M	2	I	W
Anacardiaceae	*Mangifera indica* L.	Mango (En), Muyembe (Lu)	F	2	E	F
Asteraceae	*Ageratum conyzoides* (L.) L.	Namirembe (Lu)	M	2	E	W
Lamiaceae	*Ocimum gratissimum* L.	Wild Basil (En), Mujaaja (Lu)	F	2	I	F/W
Lamiaceae	*Plectranthus amboinicus* (Lour.) Spreng.	Kamubiri (Lu)	M	2	I	W
Lauraceae	*Persea americana* Mill.	Avocado (En), Ovakedo (Lu)	F	2	E	F
Poaceae	*Cymbopogon citratus* (DC.) Stapf	Lemongrass (En), Kisubi (Lu)	F	2	E	F/W
Solanaceae	*Capsicum annuum* L.	Chili pepper (Eng), Kamulali (Lu)	F	2	E	F
Zingiberaceae	*Aframomum angustifolium* (Sonn.) K.Schum.	Madagascar cardamom (En), Matungulu (Lu)	F	2	I	W
Acanthaceae	*Justicia exigua* S. Moore	Kazunzanjuki (Lu)	M	1	I	W
Arecaceae	*Cocos nucifera* L.	Coconut (En), Ebinazi (Lu)	F	1	E	F
Aristolochiaceae	*Aristolochia littoralis* Parodi	Nakasero (Lu)	M	1	E	W
Asteraceae	*Bothriocline longipes (Oliv. & Hiern) N.E.Br.*	Twatwa (Lu)	M	1	I	W
Asteraceae	*Emilia discifolia* (Oliv.) C.Jeffrey	Mukasa (Lu)	M	1	I	W
Asteraceae	*Solanecio mannii* (Hook.f.) C.Jeffrey	Kiralankuba (Lu)	M	1	I	W

Botanical family	Botanical name	Vernacular names[a]	Use[b]	Total collection citations	Indigenous/ Exotic[c]	Wild type[d]
Asteraceae	*Vernonia auriculifera* Hiern	Kikookooma (Lu)	M	1	I	W
Cleomaceae	*Cleome gynandra* L.	Jjobyo (Lu)	F	1	I	W
Crassulaceae	*Kalanchoe densiflora* Rolfe	Kiyondo (Lu)	M	1	I	F/W
Cucurbitaceae	*Cucurbita maxima* Duchesne	Pumpkin leaves (En), Suunsa (Lu)	F	1	E	F
Fabaceae	*Cajanus cajan (L.) Millsp.*	Pigeon peas (EN), Nkoolimbo (Lu)	F	1	E	F
Fabaceae	*Phaseolus lunatus* L.	Lima beans (En), Kayindiyindi (Lu)	F	1	E	F
Fabaceae	*Phaseolus vulgaris* L.	Common beans (En), Kijanjaalo (Lu)	F	1	E	F
Lamiaceae	*Leonotis nepetifolia* (L.) R.Br.	Lion's ear (En), Kifumufumu (Lu)	M	1	I	W
Lamiaceae	*Leucas martinicensis* (Jacq.) R.Br.	Mavigabakulu (Lu)	M	1	I	W
Lamiaceae	*Mentha aquatica* (L.)	Mint (En), Nabbugira (Lu)	M	1	I	W
Lamiaceae	*Ocimum forsskaolii* Benth.	Kakubajjiri (Lu)	M	1	E	W
Malvaceae	*Hibiscus sabdariffa* L.	Rosella (En), Musaayi gwadeezi (Lu), Kisayisayi (Lu)	M	1	I	F/W
Malvaceae	*Melochia corchorifolia* L.	Chocolate weed (En), Keyeyo (Lu)	M	1	I	W
Musaceae	*Musa* spp.	Banana (En)	F	1	E	F
Myrtaceae	*Callistemon citrinus* (Curtis) Skeels	Bottlebrush (En), Mwambalabutonnya (Lu)	M	1	E	F/W
Myrtaceae	*Eugenia capensis* (Eckl. & Zeyh.) Harv.	Surinam cherry (En), Nsaali (Lu)	F	1	E	F/W
Oxalidaceae	*Averrhoa carambola* L.	Starfruit (En)	F	1	E	F
Passifloraceae	*Passiflora edulis* Sims.	Passionfruit (En), Katunda (Lu)	F	1	E	F
Poaceae	*Zea mays* L.	Maize (En), Kasooli (Lu)	F	1	E	F
Polygonaceae	*Rumex usambarensis* (Dammer) Dammer	Kisekeseke (Lu)	M	1	I	F/W
Rubiaceae	*Vangueria apiculata* K.Schum.	Spanish tamarind (En), Tugunda (Lu)	F	1	I	F/W
Rutaceae	*Citrus limon* (L.) Osbeck	Lemon (En), Nniimu (Lu)	F	1	E	F
Solanaceae	*Solanum anguivi* Lam.	Green Uganda Pea Eggplant (En), Katunkuma (Lu)	F	1	I	F/W

[a]Vernacular names: En = English, Lu = Luganda
[b]Primary use of plant species: F = Food, M = Medicinal
[c]Species: I = Indigenous, E = Exotic
[d]Wild type: F=Feral, W= Wild, W/F=Can be either feral or wild
Note: All botanical names are accepted names according to The Plantlist: http://www.theplantlist.org/.

6.3.4 Seasonality

Most wild plants were collected less than once per week during the reported months of collection (Figure 6.2). This was especially true for medicinal plants. However, 8% of the food plants were collected daily.

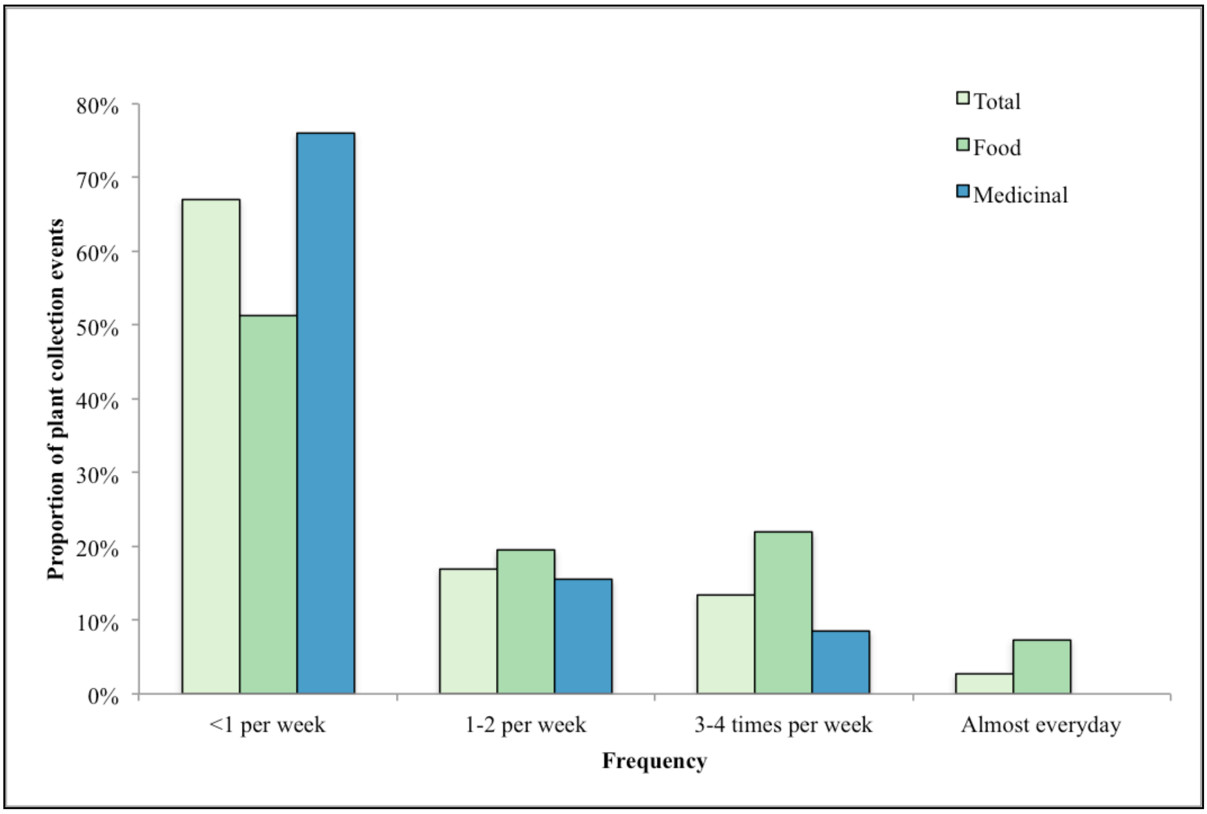

Figure 6.2 Frequency of plant collection events for food plants, medicinal plants and combined (Total).

A peak in collection events is found in March for both food and medicinal wild plants (Figure 6.3). Wild plant collection is lower during the rainy season and appears higher during the dry season. However during the six months of the recall period, seasonal variation is higher for food plant collection events than for medicinal plant collection events.

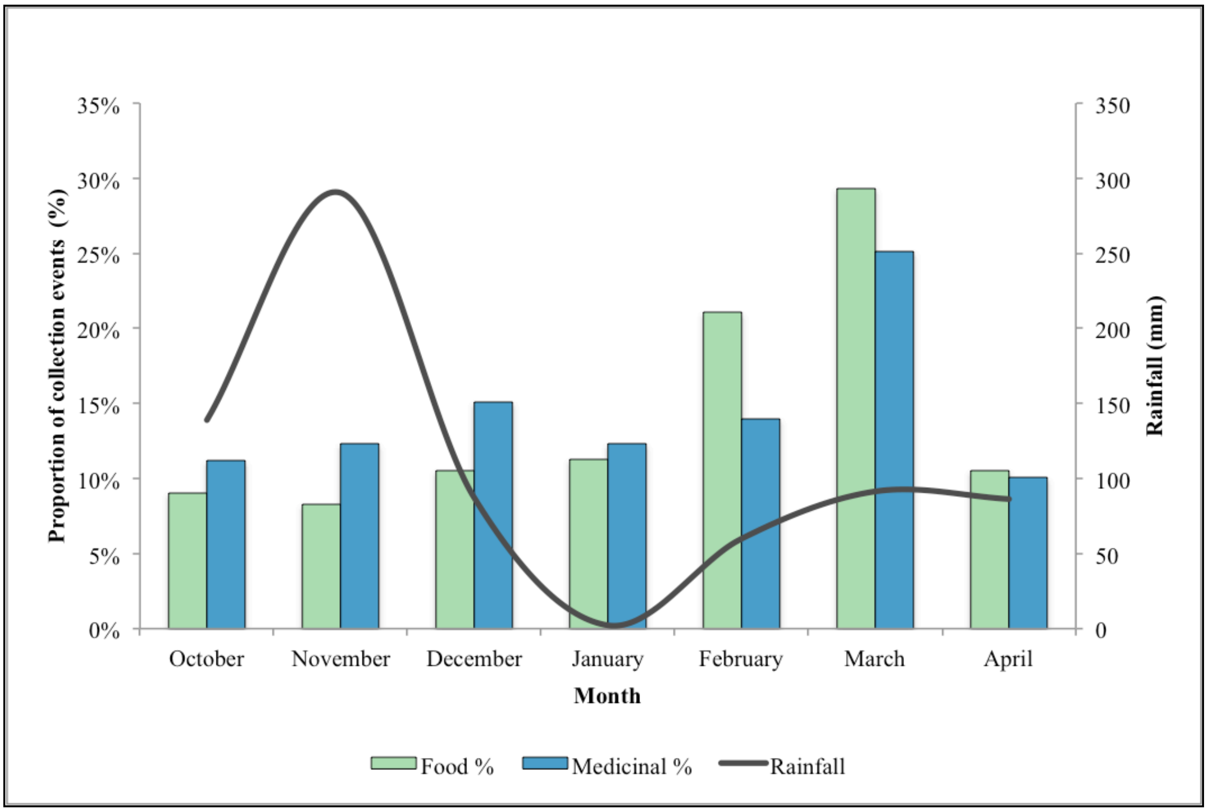

Figure 6.3 Relative number of plant collection events during the months of recall in percentages with rainfall data (Makerere Meteorological Station 2016). Numbers are frequency adjusted.

6.3.5 Attitudes and Perceptions

There is no significant difference in attitudes and perceptions towards urban collection between practitioners and non-practitioners (Table 6.5). Only three respondents, of whom one is an urban collector, think it is shameful or embarrassing to collect wild plants in the city. However, comments such as "people are no longer friendly" [to allow people to collect from their plots] and "as long as it is not on someone's land" indicate that wild plant collection is limited to certain areas in the urban landscape. Even though the respondents in general have a positive attitude towards the practice of urban collecting, pollution gives them concerns: some avoid collecting leafy green vegetables, especially grown along the roadside, due to dust and other forms of pollution.

Table 6.5 Attitudes and perceptions regarding wild plant collection for all households[(a)] (n=83) and for urban collectors (n=43).

Statement	Agrees with statement	
	All households Obs[(b)] (%n)	**Urban collectors Obs[(b)] (%n)**
1. It is an important way to feed my family, especially in times of low production (insecurity/out of necessity).	23 (28%)	14 (32%)
2. Why would I pay, if I can collect it for free?	76 (92%)	43 (98%)
3. These products are not available at the market or they are very expensive.	1 (1%)	1 (2%)
4. I know these products from my village.	27 (33%)	20 (45%)
5. These products have essential nutrients for health.	25 (30%)	18 (41%)
6. Nature is my pharmacy.	50 (60%)	31 (70%)
7. I use them to diversify my family's diet.	25 (30%)	17 (39%)
8. They are not healthy because of pollution.	24 (29%)	8 (18%)
9. They are foods for the poor.	3 (4%)	3 (7%)

[(a)]Not all 93 households were available for this part of the study, so only 83 households were included in this part of the analysis.
[(b)]Obs = number of observations

This indicates that 28% of all respondents agree with the statement that wild plants are not healthy due to pollution (statement 8), however it is important to note that all respondents who agreed with the statement also made additional comments in which they stated that vegetables (especially the road side leafy green vegetables) are polluted. Furthermore, only 4% of the respondents believe that wild food plants are for poor people only.

Of the respondents who agreed that it is an important way to feed their family, especially in times of low production or otherwise food insecure periods, only 14 (32%) considered themselves urban collectors. Nine respondents agree with the statement but did not report any collecting over the past six months.

6.4 Discussion

6.4.1 Urban Collectors

Urban collection of wild plants plays a potentially important role in people's livelihoods. Almost half of the respondents report they have collected plant resources from the urban environment in the six months preceding the interview. Even though collection is generally conducted less than weekly, it is still an integral part of people's traditions. These results fall within the ranges reported by Davenport et al. (2011) (27-70% of all households) and Schlesinger et al. (2015) (43% for medicinal plants and 53% vegetables), indicating that the size of a town may have an influence on the quantity of plants collected, but not on the abundance of urban collectors (Davenport et al. 2011; Schlesinger et al. 2015). However, our findings show a lower number of people involved in wild plant collection compared to rural areas of Uganda, where household collection of wild plant resources is expected to be between 80% and 100% (Tugume et al. 2016).

Out of all variables tested, three indicate a significant relationship with the respondent's probability to collect wild plants: *wealth, age* and *location*. Respondents younger than 51 years old are more likely to collect wild plants than elderly residents of the city. This is an unexpected finding as it tends to contradict the fact that younger people who grow up in the city are less exposed to different vegetation types and have less time to learn about the usefulness of wild plants as they often attend school (Tabuti et al. 2003b) or work. However since older people generally have better traditional knowledge on wild plant use (Tabuti and van Damme 2012), this might indicate that they instruct other members of their household to collect plants for them.

Low-income households are also more likely to collect wild plants. These findings are similar to Davenport (2011), who explains that these urban commonage resources provide vital contributions to mitigating urban poverty (Davenport et al. 2011). Furthermore, Davenport (2011) found that the length of time the respondent lived in the town had a significant influence on collection practices. Our findings however, do not indicate that a rural background results in higher collection events.

It should be noted that because the present study is part of a larger study, the sample did not include households without homegardens and therefore is limited in making statements about the general (low-income) population of Kampala. It can only be hypothesized that people without access to their own plots of land are more likely to collect more from the wild.

6.4.2 *Species collected and their use*

The findings in this study indicate that medicinal plants are more often collected than food plants. Wild medicinal plants form the main source of primary health care for most Ugandans (WHO 2002; Tabuti et al. 2003a; Tugume et al. 2016). The two most cited medicinal plants in our study, *Momordica foetida* Schumach. and *Vernonia amygdalina* Delile are both commonly used to treat malaria in tropical countries (Tugume et al. 2016). This major role wild plants have in Uganda's health care system has not gone unnoticed by the Ugandan government, who in 2015 passed a bill to upscale the use of herbal medicines and to integrate it into the main healthcare system (Uganda Government 2015).

In the USA, wild plant collection is mainly aimed at food plants (McLain et al. 2013; Poe et al. 2013). In urban Southern Africa, households reported to collect wild plants primarily for fuel (69%), but also for the provision of food (wild vegetables (53%); wild fruits (36%)) and medicine (43%) (Schlesinger et al. 2015). The difference in percentages of respondents who reported collecting wild vegetables is especially notable. These differences in findings could be explained through the fact that Kampala is a larger city, and that food plants are harder to find, or that pollution issues influence the quality of the plants much more and medicinal plants are safer to collect.

Furthermore, our definition of 'wild' includes a range of 'wildness', from natural generated herbs to feral crops to abandoned trees and finally to minimally managed plants within the landscape. This is in line with findings in other studies, i.e. Cruz-Garcia and Price (2014). However, it should be noted that many Ugandans domesticate local species in their gardens, thus making this already grey area of 'wildness' even greyer. Therefore, simply stating whether a plant species is wild or feral should not be based on species level, but on the plant individual level.

6.4.3 *Location*

Our study shows that both public and private lands are used as collection sites (39% and 41% respectively). Only 16% is collected from both types of locations, however in the peri-urban areas collection sites are more likely to be public spaces (e.g. roadsides and wetlands), whereas in inner urban Kampala, sites are more likely to be private spaces (e.g. neighbour's gardens and vacant plots). Respondents collecting in private gardens stated that they had permission from the residents. Moreover, the residents in the peri-urban areas are more likely to collect wild plants than other residents; this is similar to the findings of Gianotti and Hurley (2016) and Schlesinger et al. (2015) (Schlesinger et al. 2015; Gianotti and Hurley 2016). Not only is there higher biodiversity and (public) space for people to collect, they may also have reduced access to markets compared to the more centrally located urban households. In Kampala, people living in peri-urban areas generally have more traditional farming livelihoods (56% of farming population live off farming) than those in inner Kampala, where people live off wage work and business (only 18% of the farming population live off farming) (Sebastian et al. 2008). This difference in livelihoods is undoubtedly another factor influencing households' wild plant collection.

6.4.4 Seasonality and safety nets

Seasonality plays an important role in the use of wild food plants in people's diet outside of the harvest season when agricultural foods are expensive or not available (Merode et al. 2004; Tabuti et al. 2004; Agea et al. 2011a). We observed a peak collection activity in March when 8% of the food plant collection occurred on a daily basis. The wild collected food plants do not form a primary food source for the households included in this study. However other studies confirm that wild edible plants are not so much a replacement, but rather function as a complementary food item to diets (Termote et al. 2012; Boedecker et al. 2014).

Even though wild medicinal plants are more often collected than wild food plants, they are never collected on a daily basis and our results show less seasonal variation. These findings may indicate that food plants have seasonal peaks, based on harvest season, while medicinal plants may be collected more frequently all year round and are based on occasional need rather than seasonality (Tabuti et al. 2003b; Hamilton 2004; Tugume et al. 2016). However this study did not cover a full calendar year, therefore it is recommended that other seasons are included in further studies to exclude recall bias (Jagger 2012).

6.4.5 Attitudes and perceptions

In East Africa, increased intake of leafy green vegetables are often cited as a means to improve food security by providing vital nutrients (Grubben et al. 2014; Sogbohossou et al. 2015). They are fast growing, occur in many places and thus easily accessible. However not many respondents collect them as only 10 observations in total of three green leafy vegetables were reported: doodo (*Amaranthus dubius* Mart. Ex. Thell.), jjobyo (*Cleome gynandra* L.) and pumpkin leaves (*Cucurbita maxima* Duchesne). One explanation could be that since these species are of low height people avoid picking them from busy areas, such as along road sides, due to pollution risk. This is in contrast with fruits from trees (19 observations) that grow higher up, where pollution is not considered as much of a problem. In addition, fruits can often be peeled and eaten quickly, whereas (leafy green) vegetables are eaten whole and need cooking. This may explain why fruits are the majority of wild foods collected. Another explanation could be that fruit trees are more abundant in the landscape and yield many fruits at once. However, these are assumptions that need further research to be confirmed. Since our study focussed on the activity of urban collection rather than the psychology behind collection behaviour, a deeper understanding of what drives urban collectors would be recommended in future studies.

Traditional knowledge plays an important role in the collection and use of wild plant species (McLain et al. 2013; Poe et al. 2013). The findings in this study demonstrate that since wild plant species still play a role in people's lives, knowledge is still present among the urban residents. However it was beyond the scope of this study to include an in-depth analysis on the status of traditional knowledge and how it differs between urban and rural communities. Nonetheless it is worth mentioning that Tabuti (2012) found that in Uganda, cultural taboos and scepticism regarding the use of wild medicinal plants outside the local community, cause those who can afford it to choose allopathic medicine over traditional treatment methods (Tabuti and van Damme 2012).

A finding that indicates that in cities, whose residents are often “outside the local community”, people shun traditional treatment methods in favour of allopathic medicine. Furthermore, since the colonial period, traditional healing practices have been discouraged through the influence of ‘new’ religions and western education systems, causing some people to believe that the use of medicinal plants is ‘devilish’ (Tabuti et al. 2003b). However in our study, we did not observe a strong negative attitude that was based on cultural taboos towards the use of wild plants for medicine, and only three respondents expressed that wild edible plants were food for the poor.

6.5 Conclusion

In a world that is increasingly more urban, existing provisioning systems are challenged and a multi-dimensional development plan is needed (Godfray et al. 2010; The World Bank 2015). This study contributes to addressing the knowledge gap surrounding the use of urban wild plant resources as a means to help tackle urban challenges such as food insecurity. Almost half of the respondents reported collecting wild plants in the urban and peri-urban environment of Kampala. This indicates that wild plants form a potentially important role in the livelihoods and traditions of Kampala’s residents. Moreover, almost twice as many plants are collected for medicinal purposes than for food purposes. The findings in this study further indicate that residents with lower income, younger age (<51 years old), and predominantly living in peri-urban areas are more likely to be collectors of urban wild plants. This description of the current situation can help urban land planners and urban ecologists identify locations and species to incorporate in urban design. For example green zones can be incorporated into planning maps, with specific aims of providing wild plants for collection.

This type of study is beneficial to multiple disciplines and can contribute to a better understanding of food security issues, development of traditional knowledge systems and provide insights into the relationship between urban residents and nature in order to grow sustainable cities. Whilst urban collection of plant resources can be an important strategy for poor urban households to supplement dietary and medicinal needs, it should not be overestimated as a strategy to alleviate people out of poverty

(Davenport et al. 2011). Rather it could be seen as a potential safety net for those in times of economic hardship to enable them to access vital nutrients and medicines while preserving traditional knowledge systems. This means that urban collection should be part of a multidimensional economic development plan and municipalities should be aware of the importance of these urban resources for users. Even tough Kampala currently has limited public space to develop more parks and green open spaces, some possibilities have already emerged. Planned recreational and green space can form ideal locations as collection sites, as well as schools and health centres for local communities. In addition, businesses and private land owners can be encouraged to plant fruit trees for public use through small schemes. Accordingly, appropriate policies and urban land planning strategies can be developed with the objective of incorporating urban biodiversity to the benefit of urban livelihoods without compromising its sustainability.

7 Alternative food sources when living in the city: Coping with rising food prices in Kampala[11]

Abstract

With some of the highest urbanisation rates in the world, sub-Saharan Africa is facing serious challenges in providing sufficient and healthy foods for its growing urban populations. Fresh fruits and vegetables at urban markets are often too expensive for the poor. Alternative food sources can provide solutions to a rising urban demand for healthy, nutrient-dense foods, but only if recognised and treated as a fair alternative practice. In many countries urban farming is still considered controversial and non-metropolitan. Additionally, collection of edible wild species as an alternative food source in urban and peri-urban areas has only received scant attention in natural resource studies and development projects. Consequently, data on the importance of these alternative food sources for food security of urban communities are largely missing. This study aimed at assessing the extent and importance of urban homegardens and wild food sources for poor residents in Kampala, Uganda. A total of 96 urban and peri-urban households with homegardens were purposively selected, food plants in the gardens inventoried and respondents interviewed on socio-economic data, household food security levels, plant uses and food sources. In addition, respondents were asked about wild collection behaviour, in both urban and rural areas, as well as dependency on rural connections. The surveyed gardens can be considered highly diverse, with 73 edible plant species found, including 24 fruit, 22 vegetable, 14 condiment, eight root/tuber, four legume and one cereal species. At least a third of the identified species can be considered indigenous, species that are often underutilised yet can have important nutritional properties to enhance food and nutrition security. Furthermore, 25% of the respondents reported collecting edible species from the urban environment, 23% reported collecting in rural areas, and 33% reported being sent farm produce from relatives in rural areas within the six months preceding the interview.

[11] Mollee EM, McDonald MA, Ræbild A and Kehlenbeck K. (2016). *Alternative food sources when living in the city: coping with rising food prices in Kampala.* Conference Proceedings, Tropentag Conference: "Solidarity in a competing world – fair use of resources", 18-21 September Vienna, Austria.

These findings indicate that wild and farm plant resources play an important role in the lives of Kampala's residents, which means that in order to ensure fair access to alternative food sources policy makers and urban planners need to be aware of diverse land use types and incorporate them in future development plans.

Keywords: Food security, natural resource management, nutrition, Uganda, urban farming, wild food plants

7.1 Introduction

With some of the highest urbanisation rates in the world, sub-Saharan Africa is facing serious challenges in providing sufficient and healthy foods for its growing urban populations and Kampala, Uganda, is no different (The World Bank 2015). Food prices are growing disproportionally faster than those of other basic goods and services (Sabiiti et al. 2014). In urban areas, people are mainly dependent on markets (Benson et al. 2008), but many urban poor can't afford the high food prices at the markets, resulting in high levels of food insecurity. Urban farming and rural-urban linkages (when friends or relatives send produce from the village to the city) have been described as important alternative coping strategies (Maxwell 1995; Sebastian et al. 2008; Pottier 2015). Yet, studies of these alternatives are often focussed on food calories (carbohydrate-rich staple foods) and give little information on other food types and diversity. Collection of edible wild species as an alternative food source in urban and peri-urban areas has received even less attention in food security studies (Kaoma and Shackleton 2014; Schlesinger et al. 2015; Mollee et al. 2017). These alternative food sources can provide solutions to a rising urban demand for healthy, nutrient-dense foods, but only if recognised and treated as fair alternative practices (Herforth 2010a; Pottier 2015). Moreover, analysing food insecurity coping mechanisms separately for the different food groups, including for example fruits and vegetables, gives a relatively simple indication of how these alternatives contribute to a healthy, diverse and nutritious diet (FAO 2008). Data on the importance of these alternative food sources for nutrition security of urban communities are largely missing. This study aims at filling this knowledge gap by assessing the extent and importance of alternative food sources of different use categories for poor residents in Kampala, Uganda.

7.2 Material and Methods

Fieldwork took place between February and September 2015 in Kampala, Uganda. A total of 96 households with homegardens were purposively selected in *inner urban, outer urban* and *peri- urban* areas of the city. In each area three neighbourhoods (clusters) were selected. All food plants in the gardens were inventoried and respondents were interviewed on socio-economic data and their use of alternative food sources during the six months preceding the interview. The alternative food sources included were: urban wild collection, rural wild collection and food plants sent from the village by friends and/or relatives. Next, all food plants were categorised into one of the following food groups: *Cereals, Condiments, Fruits, Legumes, Roots & Tubers,* and *Vegetables* (FAO 2008). Finally, relative proportions of food groups per food source were compared.

7.3 Results and Discussion

The surveyed homegardens can be considered highly diverse, with 73 edible plant species found from six food groups (Figure 7.1). Almost all gardens provided the households with fruits (total of 24 plant species), vegetables (22 species) and condiments such as sugarcane and herbal teas (14 species). Roots & tuber, including the plantain (matooke) were found in 79% of the gardens (eight different species). Only 27% of the gardens provided legumes (four species) and even less, 8%, of the gardens had maize (one cereal species). At least a third of the identified species can be considered indigenous, species that are often underutilised yet can have important nutritional properties to enhance food and nutrition security.

Only 25% of the respondents reported collecting edible species from the urban environment at least once during the six months preceding the interview (Figure 7.2). Typically, these households collected leafy green vegetables (e.g. *Amaranthus dubius*) and fruits such as mango (*Mangifera indica*) and jackfruit (*Artocarpus heterophyllus*) from urban areas. Furthermore, a similar number of respondents, 23%, reported collecting food plants in rural areas at least once in that same time frame. This occurred mainly when visiting their village and comprised of starchy staples such as cassava (*Manihot esculenta*), plantain (*Musa* spp.; matooke), and sweet potato (*Ipomoea batatas*). A third of the households, 33%, reported being sent farm produce from relatives or friends in rural areas during the six months preceding the interview (Figure 7.2). These products, too, were mainly cassava, plantain and sweet potato.

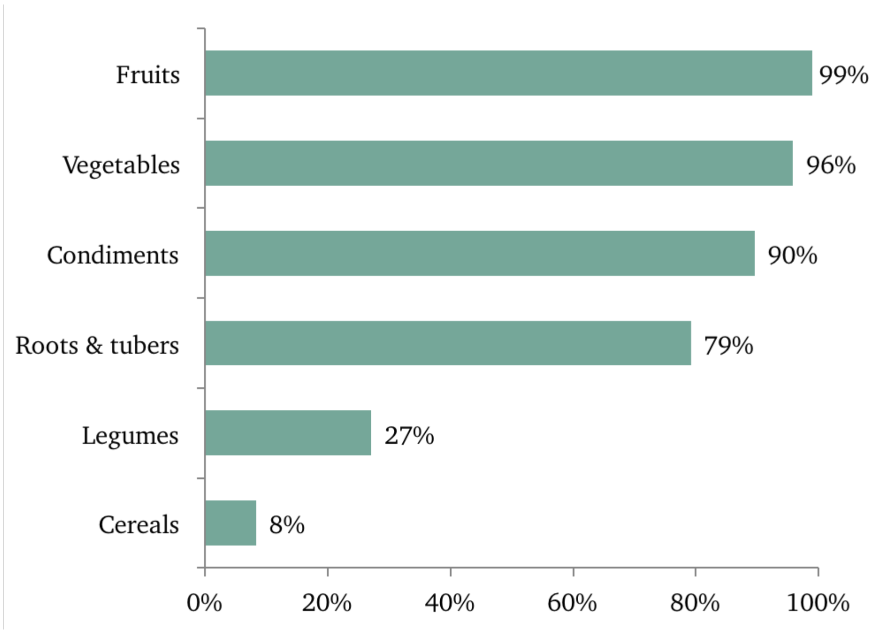

Figure 7.1 Proportion of urban homegardens (n=96) in Kampala, Uganda, containing at least one plant species in a food group, separately for six food use groups.

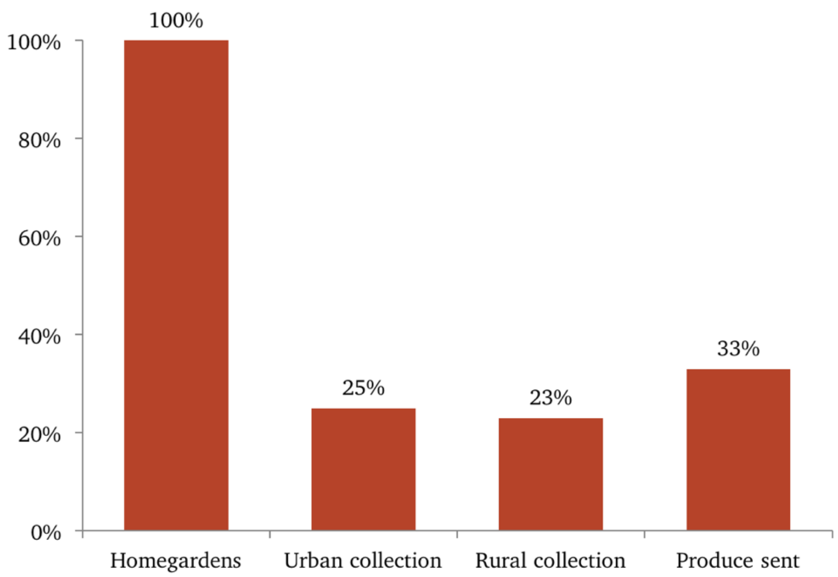

Figure 7.2 Proportion of households included in this study (n=96) in Kampala, Uganda, that had used the alternative food source homegarden, urban collection, rural collection or produce sent at least once during the six months preceding the interview.

We compared the four different alternative food sources according to their proportional contribution to the six different food groups (Figure 7.3). Urban collection predominantly provided fruits (50% of all food items collected in urban areas were fruits) and vegetables (30%), while homegardens mainly provided vegetables (40%) and roots/tubers (35%), crops that don't use much space and are easy to cultivate. Urban collection predominantly focussed on tree fruits, which can be found along the road, on vacant plots and given away by friendly neighbours. Vegetables were not often collected in urban areas and respondents considered their leaves as 'dirty'. Contrarily, mainly starchy roots and tubers were collected from the rural areas or sent by relatives/friends (55% of all food items mentioned for these categories; Figure 7.3).

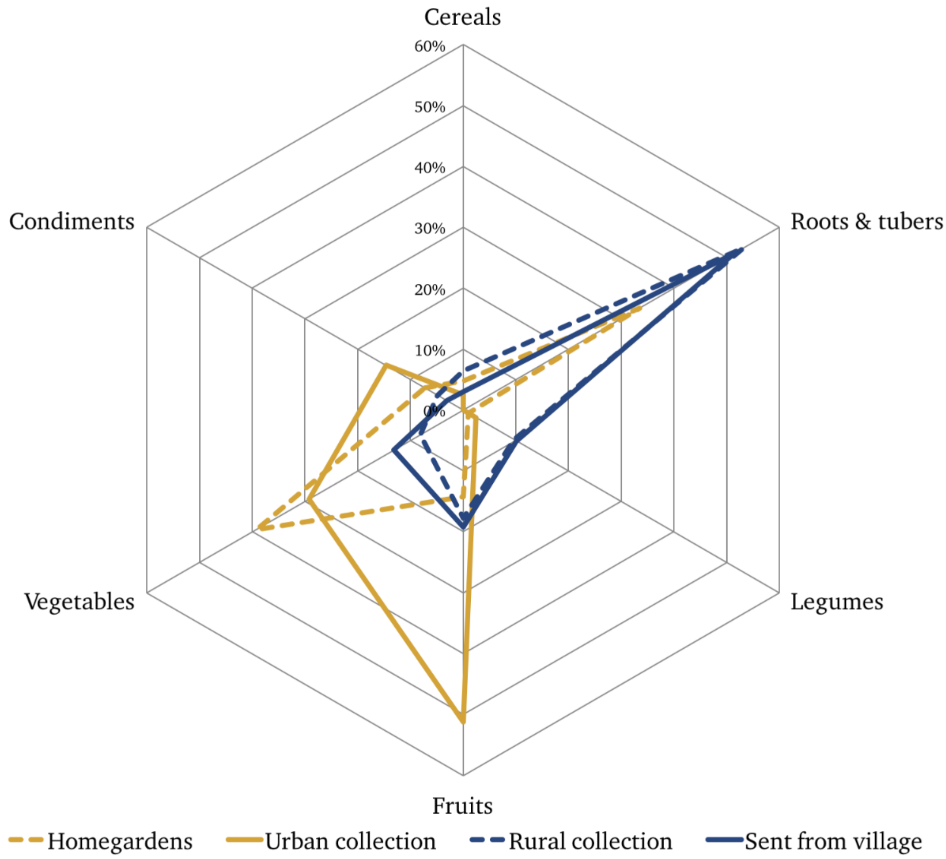

Figure 7.3 Radar diagram of proportions of food groups per alternative food source as given by 96 respondents in Kampala, Uganda. Total percentage of food group summed up for each alternative food sources equals 100%.

This study did not include frequency and amount of any collections made, therefore the actual contribution to household food and nutrition security should not be overestimated. Furthermore, because this study was part of a larger project that focused on urban homegardens, its main limitation is the fact that we excluded households without homegardens. Since homegardens are known to contribute to food security in a nutritionally diverse way (Bernholt et al. 2009), the frequency and importance of urban or rural food collection might be even higher for poor urban households without homegardens.

7.4 Conclusions and Outlook

Alternative food sources play an important role in the lives of the surveyed households in Kampala and are used for different dietary needs, which can, when combined, contribute to a more diverse diet. Starchy staple foods are predominantly sourced from the rural areas, and fresh fruits and vegetables from the urban environment, including both private homegardens and public spaces. By comparing the different alternative food sources separately for different food groups we could better understand how the respondents cope with rising food prices by finding alternative sources for certain food groups, yet ensuring a diverse diet of their families. Urban cultivated and wild agrobiodiversity should therefore be considered as a potentially important food source, but more quantitative studies are needed to assess the actual contributions of these food sources to family nutrition. We encourage researchers, policy makers and urban planners to consider urban cultivated and wild food sources and incorporate them in future urban development plans for improved nutrition of the urban poor.

8 General discussion

The overall aim of this PhD was to gain a better understanding of the current and potential contribution of urban plant resources to human wellbeing in Kampala. I chose to do this by combining three main academic disciplines: ecology, ethnobotany and human nutrition.

This approach, in the context of an urban setting, has had very little attention in the literature so far. However, my overall findings of Kampala as a plant species rich environment provide interesting insights. In this discussion, I shall compare the main findings of the individual studies and discuss them in a larger context.

8.1 Urban plant diversity hotspots

The homegardens included in this study (Chapter 4) are similar to the "biodiversity hotspots" as described by Galluzzi et al. (2010). With 270 species identified during the homegarden inventories, Kampala's homegardens can parallel their rural counterparts in terms of species richness and diversity. However, the more interesting result from this study is the high use value of the gardens with 248 (92%) plant species. While exploring the use categories further, a higher number of medicinal and edible plant species are found. These species contribute to people's most basic needs (Millenium Ecosystem Assessment 2005). The 70 edible plant species provide new possibilities for these homegardens as preservation sites for underutilised food plants as well as to provide resilience to food insecurity. Even though none of the species found is considered endangered according to IUCN, the fact that at least a third of the species found are considered indigenous, makes these gardens still *circa situ* conservation sites.

8.2 Urban food security and nutrition

The dietary diversity and fruit consumption study (Chapter 5) did not provide evidence that higher garden plant species richness and diversity correlates with better dietary diversity and fruit intake during the fieldwork season. However, comparisons with secondary data indicate that children with access to homegardens may have better nutritional status than children who do not have this option. Moreover, the number of food items that was provided by the garden (5%) and neighbours (33%) increases the possibility that urban production does in fact contribute to urban food security.

The individual food items collected during the dietary recalls (Supplement Table 5.7) were mainly common food crops, although some local vegetables (Uganda eggplants, Amaranth species and carrot greens) were mentioned too. These are considered underutilised food plants which were also found in the gardens (Chapter 4 & 5) and should therefore be considered for further research.

8.3 From across the urban landscape

Urban public space was used for collecting plant species for food and medicine by 47% of the respondents (Chapter 6). This indicates that useful species are not only provided by gardens (Chapter 4), but that they are collected from the “wild” as well. Collection was more likely to occur in peri-urban areas where collection space is more available. Medicinal species were most dominant in both settings, and the literature about these urban herbal medicinal species is rare. However, in Uganda wild medicinal plants form the main source of primary healthcare (WHO 2002; Tabuti et al. 2003a; Tugume et al. 2016).

8.4 Urban and rural linkages

Urban-rural linkages have been important as urban food security coping strategies (Maxwell 1995; Sebastian et al. 2008; Pottier 2015). Comparing the food plants available in the urban gardens (Chapter 4) with the edible plant species collected (Chapter 6), and those from rural sources there is variation in food groups sourced from the different sites. For urban collection, the largest proportion of food plants were fruits, while in homegardens it is vegetables and roots combined.

9 General Conclusion

The main finding in my PhD study is the high richness and diversity of useful plant species in Kampala. Where previous literature has often focused on cultivated species only, this study provides insight into the enormous diversity and richness of useful plant species in homegardens and public space.

Although the role of these gardens as well as Kampala's urban "wild" space should not be overestimated in food security terms, their opportunities to function as safety nets in times of hardship and to provide medicine as well as function as *circa situ* conservation sites provides reason for more attention.

Biodiversity and green structures should be included in urban landscape designs to create holistic sustainable cities. However, this requires transdisciplinary collaborations between city planners, ecologists, human nutritionists and ethnobotanists. To provide healthy and food secure cities, various strategies need to be considered and new opportunities explored. This 'out-of-the-box' thinking should push urban gardening into a direction that makes it more 'urban', and healthier. Different ways of thinking provide opportunities to make it more efficient, nutritious, as well as culturally and spiritually inspiring. These are necessary steps that need to be taken to keep urban gardens and urban green space worthy of being in the city without being thought of as rural or polluted. Most importantly it provides Kampala with an opportunity to remain a leading green Garden City.

10 Critical assessment and recommendations

10.1 Critical assessment of my PhD research

While I carefully considered methods and approaches during design of my study, a number of uncertainties still remain.

Firstly, the design. To conduct an ideal random sampling design, whether by map or list is difficult in the urban context. The sampling design became purposive and although our wealth indicators provide enough information to distinguish between the households in a relative way, our sample should be considered as low income. However, a better understanding of the dietary contribution of these homegardens would be better understood when compared with households without homegardens.

Secondly, to genuinely understand the contribution of homegardens to household food security and nutrition, a researcher should ideally stay with a household and measure all yields. Yield estimates are notoriously difficult to get and original attempts from my side have failed to acquire this data due to the time demands, and my priority to cover several studies within one season (both garden diversity and nutrition).

Thirdly, to really understand diets and nutrition, one should not only look at the ingredients, but also consider cooking methods and portion sizes. Since these methods are time consuming and my questionnaires were already extensive I opted out of conducting this type of study. However, I am fully aware that if one really wants to understand nutrition and nutritional intake on such a micro level, these details are of vital importance.

And finally, the loss of samples due to various reasons. Of the original 98 gardens inventoried on the first visit, 96 households completed the three rounds of surveys. However due to missing values, mainly in species count data, I decided to continue the analyses only with complete datasets of the gardens, which resulted in 74 gardens (Chapter 4). For the nutrition study (Chapter 5), I was even more restricted, we only completed Dietary Diversity scores for 49 children in the required age group. From the original 60 children included, at least ten were too old/young, or mistakes were made in the anthropometric measurements and had to be excluded from further analyses.

The reduction of homegardens included in the final analyses from 96 to 74 gardens also meant a reduction of total species richness, from 311 plant species to 270. The 41 plant species that were then excluded, consisted of eight food plants, 14 medicinal species, five technical species, two ornamental species and 12 weeds.

10.2 My research priorities

Building on the results of my doctoral work presented in this thesis, there are several concepts that I would like to work on. Some involve additions to the manuscripts included in this thesis to improve overall quality and content, others are new manuscripts entirely, however for which most data are already collected:

- A cluster analysis will be conducted and added to the manuscript of chapter 4. I plan to do a Euclidean (Ward) hierarchical cluster to determine garden typologies. However, I am also exploring other options of analyses that may prove to give more reliable results or are better suited for this type of data.
- In chapter 5 I focus on fruit consumption of the children in the households, but since fruit consumption is generally low and micronutrients can also be gained from other (leafy green) vegetables, I want to add the vegetable consumption data to the manuscript as well.
- Now that we have contextual information and a baseline of present tree species in Kampala, I plan to study the role of fruit trees in more depth. Seasonality data and preference data is currently being collected for this study, and findings will be compared to similar studies conducted in West and Eastern Uganda.
- A rather unexpected finding from this PhD study is the high amount of medicinal plant species found in the gardens. Medicinal plant species in the urban environment have had virtually no attention in the literature (as I explained in chapter 6), yet can form equally important contributions, if not more, to household health as fresh fruits. For example, herbs used as deworming

medicines provide a child the ability to absorb the vitamins provided by fresh foods.

10.3 Recommendations for future research

- A more elaborate study where dietary habits and the contributions of gardens are compared to those without gardens.
- *Seasonality*: A study that gives a better understanding of the role of urban plant resources and their use during the year.
- In line with the previous point, collection behaviour is still very poorly understood. Chapter 6 only gives a glimpse of the extent of wild plan collection. A comparison with households who lack access to a self-owned homegardens would be highly recommended.
- The individuals interviewed showed high levels of plant use knowledge/ethnobotanical knowledge and from all ages. The general idea that this type of indigenous/local knowledge is disappearing might be true, however findings in this study still provide enough reasons to believe that these plants still play important roles in people's lives.
- Conduct comparisons between cities in other countries and regions.

10.4 Recommendations for identified beneficiaries and key actors

- Those working in urban planning and urban greening should seek input from multiple other disciplines to understand the role of urban plant resources to Kampala's residents to design an inclusive city.
- New ways should be studied to improve resiliency urban dwellers. This means that more efficient ways and practices should be tested and improved in a collaboration between urban gardeners, nutritionists, academics and other stakeholders, to work together creating solutions that fit the urban context and are not 'simply' adopted from rural farming practices. This means that highly nutritious food crops should be selected, and cultivation methods developed that

reduce the effects of urban challenges such as pollution and theft, which currently leaves people avoiding cultivating particular food plants.

- The main findings in this study are the high use value of the plant species present in the gardens. This creates an incredible opportunity for many stakeholders to act upon. Firstly, the gardens provide options for increased urban food security. However, secondly, the richness and use values of the species found also provides possibilities to preserve local knowledge. Something that has received very little attention within the urban environment. There is a role for academics, activists and policy makers to preserve these knowledge systems, but also to acknowledge to the gardeners how important their gardens are and that their efforts are important to their cultural history and their communities.
- Innovative ways should be sought out to increase and maintain urban green and plant resources. Since much of the urban space is privately owned schemes and collaborations should be explored with land and local business owners. In a way that benefits all people in the city. For example local businesses, schools and health centres are ideal locations to include community members in the design and use of open space.

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Annexes

Annex 1 Collection Instruments

Survey Code:

Protocol Collection Instrument Plot Survey (Part 1)

These will provide information on species abundance, seasonality and provisioning services of the trees, shrubs, fruits and vegetables.

Aims of this part of the study:
1. To analyse plant species richness, abundance and diversity in home gardens of urban to rural Uganda
2. To determine the ratio of underutilised and indigenous fruit trees and their role for food and nutrition security of the gardeners' families.
3. To determine socioeconomic and bio-physical/geographical factors affecting plant species richness and diversity.
4. To evaluate the suitability of home gardens for *circa situm* conservation purposes of plant genetic resources, particularly of IFT species.

Sampling
The aim is to cover 90 HH in total are selected according to a stratified cluster sampling strategy. However in order to ensure we can include 90 for eventual analysis and make up for possible outliers, the aim is to cover 99 households in total.
Strata: 3 – Inner urban (aka old Kampala), Outer urban (new Kampala), and Peri-urban.
Clusters: 3 clusters each of 11 households randomly selected in each stratum. This means 11 HH * 3 clusters * 3 strata = 99 HH in total.

Visits
Each HH will be visited twice. This is the first visit and covers the introduction and the plot survey, so hh will be contacted and asked for their cooperation in the whole study. The second visit will cover the household survey, dietary survey and use of wild species.

Two teams will conduct the plot survey, each having a list of households to visit during a day and the goal is to cover on average 2 households per day per team, making a total of 4 households per day.

Measurements and notes
- Plot sizes are asked or estimated and later measured with gps as it was found asking to measure the plot was too intrusive.
- Trees are measured with DBH (Diameter at Breast Height), meaning the circumference of tree stem at 137 cm height, if tree is smaller then 137 cm note down 0.
- Banana tree clusters (and all other similar crops) are counted as one.
- For each species the use is documented, if a fruit tree is there but does not provide fruits yet. Note down "none" for use.
- All uses are noted, so for example a tree provides "fruit" and "firewood" both are noted, or a species can be "food" and "medicinal".
- Include all livestock found also and for poultry please note whether they are Layers, Broilers, Kuroilers (a meat & egg hybrid), and whether they are local or exotic breeds.
- Make separate notes for homestead and other plots
- When you don't know the name of a species/variety, then please make a note, take a picture (with a reference in it written on a piece of paper) and/or take a specimen for later identification. Make sure you take good notes…

No.	Question Text	Codes / Skip Instructions		Answers and comments
1	Enumerator ID	[Names of Team members]		
2	Location	Coded		
3	Date & Time of Interview	[Generate code using this format:] YEAR.MO.DAY.HOUR		
4	GPS Location of Interaction/Interview	[Generate GPS location with phone and put a waypoint, this location should match the one given for a visit]		
5	Enumerator: Is the listed household available for interview?	**[Drop-down]** 0= Yes, and they are available to continue (>>continue) 1= Yes, but they are not home or available to continue at time of visit (>>Ask if another time is more convenient and make an appointment then go to next on the list) 2= No, they refused (>>end survey and go to nearest plot available, or next on the list)		
6	***Enumerators: Please 'read' the consent form to the participant***			
7	Are you willing to participate in this study? *Enumerator: Have the participant sign the consent form before or after the interview.*	0=I am willing to participate 1=I am not willing to participate (>>end survey)		
8	Name of the interviewee	Record name		
9	Sex of respondent	0=male 1=female		
10	Age of respondent	*Open Question*		
11	What is the relationship between the respondent and the household head?	1= Is the HH Head 2=Spouse 3=Son/daughter 4=Grandchild 5=Parent of head or spouse	6=Nephew/niece 7=Other relative 96=Other (specify) 99=Refused	
12	Who is in charge of the garden? *Enumerator: please ask to walk through the garden with the person most knowledgable.*	0=The interviewee 1=Other (specify)		
13	Can you please provide contact mobile phone numbers that we can use to contact you or another household member for a follow-up interview?	[Allow for input up to 4 telephone numbers, which should be 10 digits]		

No.	Question Text	Codes / Skip Instructions	Answers & comments
1	Did you ever receive training in Urban Farming practices? *Note to enumerator: We want to know about plants and crops so livestock is not the interest here.*	*[Select all that apply]* 0=no 1=yes, but more than 10 years ago 2=yes, but 5-10 years ago 3=yes, but 2-5 years ago 4=yes, in the past 2 years	
2	Did you ever receive benefits, such as tools, financial support or other for your urban farming? *Note to enumerator: We want to know about plants and crops so livestock is not the interest here.*	[*Select all that apply*] 0=no 1=yes, but more than 10 years ago 2=yes, but 5-10 years ago 3=yes, but 2-5 years ago 4=yes, in the past 2 years	
3	Do you ever hire labourers to help you?	0=No 1=Yes	
4	Do you experience any (other) challenges?	*[Select all that apply]* 0=No 1=Theft 2=Flooding 3=Foraging by animals 4=Drought 5=Pests/diseases, (specify) 6=Rotting, post-harvest issues 96=Other (specify)	
5a	What would you like to plant in this homegarden that you do not currently have? *What plants are missing from your* homegarden*?*	Open question record answer	
5b	Why are you not growing those now?	Open question record answer	
6	How many plots that you grow foodstuffs on do you currently have access to? *Enumerator: plots include roadsides and wetlands*	*[Select all that apply]* 0 = 1, only around the homestead (skip next) 1 = 1 away from the homestead 2 = 2 away from the homestead 3 = 3 away from the homestead 4 = 4 away from the homestead	
6a	In case there is another plot, is it in a village or urban and how is it characterised. So *where* (and *what* they mainly grow there.	*Open question*	
6b	How far is the other plot from the home?	….in mtrs/km ….in minutes	

No.	Question Text	Codes / Skip Instructions	Answer/comments
7	What best describes your access to this land (the homestead)?	1= I (or my family) have/has a garden on a plot of land that we leasehold 2= ownership under Mailo system 3= Private ownership 4= I/we rent the plot on a longer term basis 5= I have a garden plot/plots, but I am squatting there (so I'm not sure if I will be able to get my harvest) 96=Other (specify) 98=Don't know 99=Refused	
8	Since when have you been farming here plot?	----yrs	
9	Are you allowed to plant whatever you want?	0=No 1=For some species, specify…. 2=Yes	
10	What is the plot size? *Enumerators: Please measure with the tape measure*	[Record measurements or estimate]	
11	What types of farming can be identified? *Look around and note down what you see, you can also probe a little if you are not sure.*	**[Select all that apply]** 1= homegarden (on homestead) 2= garden plot away from home 3= wetland 4= roadside 5= sack gardening 6= vertical farming (e.g. hanging bottles) 7= aquaponics 8= fish farming 9= poultry 10=livestock 11=pigs 12=rodents (e.g. rabbits, guinee pigs etc) 13=Beekeeping 96=0ther….(specify)	

For Livestock

Animal	Breed	Type	Abundance	Products used	Subsistence/ Market/Both	Additional comments

For Poultry write: Layers, Broilers or Kuroilers (a hybrid chicken from India, famous for both meat and eggs)

Survey code and Pg#:

General for plants						Provisioning services as used by the HH										**Trees** and other **fruit bearing plants**					All	Med	Other uses (e.g. cosmetics, living fence, fibre, biofuel, household articles, insect repellents), comments and/or photos:
HG or **Pl**ot	Scientific, English and/or Local names	**T**ree/**S**hrub/**H**erb/Tuber/ Roots/**O**ther	Abundance	Origin*	Parts used	*Food*	*Medicinal*	*Stimulant*	*Condiment*	*Ornamental*	*Livestock fodder*	*Firewood/Charcoal*	*Timber*	*Technical use such as Fiber or dye*	*None*	Trees Measurement: DBH	Bears fruit but not used	Age on farm (yrs)	Seasonality 0=all year, 1= Seasonal**	*Months_Spec trees*	**S**ubsistence only/ **M**arket purpose/ **B**oth	Knowledge of medicinal purposes Y/N	

* Where did you get the planting materials for this plant?
0=from village cultivated, 1=from village wild, forest or other wild place (field, road side), 2=from neighbour/friend/relative in the city, 3=buy fruits from market and save the seeds, 4=buy seeds/seedlings from traders / nursery, 5= was here already, 6= Grew here by itself (eg birds/wind), 7= from the city wild, 96=Other (specify)

Survey/HH Code:

Informed Consent Sheet for Participants in a Home Garden inventory and Dietary Diversity Study in Kampala as part of the research project "The Use of Urban Biodiversity for Health and Livelihoods"

Introduction

Hello, my name is …….. and we are doing research for the University of Bangor in the UK on urban gardens and food security issues in Kampala. I am going to give you information and invite you to be part of this research. Please ask me to stop as we go through the information and I will take time to explain. If you have questions now or later, you can ask them any time.

Purpose of the research & Type of Research Intervention

Malnutrition is making many people sick in your community. We want to find ways to stop this from happening. We believe that you can help us by telling us what you grow and what you eat. We also want to know more about local production and collection of foods because this knowledge might help us to learn how to better promote and help people give the healthy foods they deserve.

This research will involve your participation in three visits from us. If you agree to participate in this study, we will do a survey of your garden today and in come back between now and mid March to talk to you about your food consumption, a short final visit will follow shortly after the second.

Voluntary Participant Selection

You are being invited to take part in this research because we feel that your experience can contribute much to our understanding and knowledge of local food and dietary practices. Your participation in this research is entirely voluntary. It is your choice whether to participate or not.

- *Do you know why we are asking you to take part in this study? Do you know what the study is about? Do you know that you do not have to take part in this research study, if you do not wish to? Do you have any questions?*

Procedures

We would also like to know a few of your household details, but will treat this information confidential and anonymous. If you do not wish to answer any of the questions during the interview, you may say so and I will move on to the next question. The information recorded is confidential, and no one else outside the research team will have access to the information documented during your interview nor will anyone outside the team be able to link you to the information you provide us.

Benefits & Reimbursements

There will be no financial benefit to you, but your participation is likely to help us find out more about how to prevent and treat malnutrition in your community. However we will give you a small token of gratitude for your time after the last interview.

Sharing the Results

Nothing that you tell us today will be shared with anybody outside the research team, and nothing will be attributed to you by name. We will publish the results so that other interested people may learn from the research.

- *You can ask me any more questions about any part of the research study, if you wish to. Do you have any questions?*

Signature:

Do you agree to participate in this study? Yes/ No

______________________ 9

Survey Code:

Protocol Collection Household and Dietary Survey (Part 2)

The main aims of this survey is to answer the following research questions:
Aims of this part of the study:
To find out if households with a higher garden diversity have better nutritional diversity.

Therefore sub-aims are:
1. To determine household nutrition and food diversity of mothers and children
2. To determine household food security

Sampling
The aim is to cover 90 HH in total are selected according to a stratified cluster sampling strategy. However in order to ensure we can include 90 for eventual analysis and make up for possible outliers, the aim is to cover 99 households in total.
Strata: 3 – Inner urban (aka old Kampala), Outer urban (new Kampala), and Peri-urban.
Clusters: 3 clusters each of 11 households randomly selected in each stratum. This means 11 HH * 3 clusters * 3 strata = 99 HH in total.

Visits
Each HH will be visited three times. This is the second visit and covers the household survey and dietary survey and use of wild species. The third visit will only be an addition 24-recall and includes the anthropomorphic measurements. One enumerators will conduct the HH and dietary survey with a list of households to visit during a day and aims are to cover on average 4 to 5 households per day per enumerator.

Note: This questionnaire is mainly aimed at women aged between 20-40 as they are in the main caregivers and cooks in the household, and one child aged 2-5 in the household as the index child will be chosen. However we saw many grandmothers at home. Try to find an index child and then interview the caretaker, whether it is the grandmother or not. If there is no child, try to find a woman of childbearing age.

1. General Survey Information

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	Enumerator ID	**Name**	
2	Location	**Coded**	
4	Date & Time of Interview	YEAR.MO.DAY.HOUR [e.g. 201411011530]	
5	GPS Location of Interaction/Interview	[Generate GPS location, this location should match the one given for a visit]	
6	Visit number	1 = HH info and dietary recall 2 = only dietary recall (on a non-consecutive day)	
6	*Please remind the household about the study and ask if you can continue*		
6	Enumerator: Is the listed household available for interview?	0= Yes, and they are available to continue (>>continue) 1= Yes, but they are not home or available to continue at time of visit (>>Ask if another time is more convenient and make an appointment then go to next on the list) 2= No, they refused (>>end survey and go to next on the list) 3= No, there is nobody present (>>end survey and go to next on the list, try again later) 4= HH/plot not known/found (>>end survey and go to next on the list, try again later) 5= No, they moved (>>end survey and go to next on the list)	
7	Is the participant the same person as the one in the garden survey?	0=No 1=Yes (skip next)	
7a	How are they related?	Open question	
8	Can you please provide contact mobile phone numbers that we can use to contact you or another household member for a follow-up interview?	[Allow for input up to 4 telephone numbers, which should be 10 digits]	

2. Household Information

2 A. HOUSEHOLD ROSTER

Enumerator: "In the first part of the survey I would like to gather some basic household information, such as your household size and structure, are you ready?" (<u>Enumerator: continue when respondent agrees)</u>

N.	Question Text	Codes / Skip Instructions	Answers & Comments
1	Name of respondent ***Enumerator: If the respondent does not want to give the true name an alias is also fine or simply the first name. The reason is mainly to be able to address the respondent by a name.***	[Insert name]	
2	Age of respondent	[insert age]	
3	What is the relationship between the respondent and the household head?	1=Head 2=Spouse 3=Son/daughter 4=Grandchild 5=Parent of head or spouse 6=Nephew/niece 7=Other relative 96=Other (specify) 99=Refused	
4	Highest level of completed education	0=No formal schooling 1=Lower Primary (1-3 years) 2=Upper Primary (4-7 years) 3=Secondary O level 4=Secondary A level 5=Vocational School 6=Tertiary 7=University 96=Other, specify 98=Don't know 99=Refused	
5	Is the respondent the main caregiver of the index child?	0=no 1=yes	
6	What is the relationship if the caregiver (respondent) to the index child?	1=biological mother 2=adoptive-, or stepmother/father 3=grandmother/grandfather	

		4=father 5=sibling 6=other relative such as aunt, uncle, cousin 96=other, specify 99=Refused	
7	Marital status	1=married 2=cohabitating 3=single 4=widowed 5=separated or divorced 96=other, specify 99=refused	
8	How many members, including you, are you in your household in total? We consider a household to include everyone who lives here and eats from the same pot. *Enumerator: Please INCLUDE all individuals who have been here for at least 6 of the last 12 months. Please also INCLUDE children who are in boarding school. Do NOT INCLUDE occasional guests (who stayed for less than 6 months of the last 12 months).*		
8a	I would like to make a list of your household members, according to age groups: *How many children between 0-2?*		
8b	*How many children between 2-6?*		
8c	*How many children between 6-12?*		
8d	*How many children between 12-18?*		
8e	*How many adult men (18+)?*		
8f	*How many adult women (18+)?*		
9	Does the index child attend school?	0=no 1=yes, government run 2=yes, a private, NGO, religious or boarding school 98=don't know 99=refused	

SECTION 2 B: INDIVIDUAL CHARACTERISTICS

Enumerator: "Thank you we will not continue with some household characteristics."

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	What is your PRIMARY ethnic group?	11. Acholi 12. Alur 13. Baamba 14. Babukusu 15. Babwisi 16. Bafumbira 17. Baganda 18. Bagisu 19. Bagungu 20. Bagwe 21. Bagwere 22. Bahehe 23. Bahororo 24. Bakenyi 25. Bakiga 26. Bakhonzo 27. Banyabindi 28. Banyakole 29. Banyara 30. Banyarwanda 31. Banyole 32. Banyoro 33. Baruli 34. Basamia 35. Basoga 36. Basongora 37. Batagwenda 38. Batoro 39. Batuku 40. Batwa 41. Chope 42. Dodoth 43. Ethur 44. Ik (Teuso) 45. Iteso 46. Indian 47. Japadhola 48. Jie 49. Jonam 50. Kakwa 51. Karimojong 52. Kebu 53. Kuku 54. Kumam 55. Langi 56. Lendu 57. Lugbara 58. Madi 59. Mening 60. Mvuba 61. Napore 62. Nubi 63. Nyangia 64. Pokot 65. Sabiny 66. So (Tepeth) 67. Vonoma 96=Other (specify)	
2	What are the OTHER ethnic groups of people in your household?	**[Select all that apply from above]**	
3	n which region and district were you born?	(see table below)	

CENTRAL		EAST		NORTH		WEST	
District		District		District		District	
Buikwe	Lwengo	Amuria	Katakwi	Abim	Kotido	Buhweju	Kiruhura
Bukomansimbi	Lyantonde	Budaka	Kibuku	Adjumani	Lamwo	Buliisa	Kiryandongo
Butambala	Masaka	Bududa	Kumi	Agago	Lira	Bundibugyo	Kisoro
Buvuma	Mityana	Bugiri	Kween	Alebtong	Maracha	Bushenyi	Kyegegwa
Gomba	Mpigi	Bukedea	Luuka	Amolatar	Moroto	Hoima	Kyenjojo
Kalangala	Mubende	Bukwa	Manafwa	Amudat	Moyo	Ibanda	Masindi
Kalungu	Mukono	Bulambuli	Mayuge	Amuru	Nakapiripirit	Isingiro	Mbarara
Kampala	Nakaseke	Busia	Mbale	Apac	Napak	Kabale	Mitooma
Kayunga	Nakasongola	Butaleja	Namayingo	Arua	Nebbi	Kabarole	Ntoroko
Kiboga	Rakai	Buyende	Namutumba	Dokolo	Nwoya	Kamwenge	Ntungamo
Kyankwanzi	Sembabule	Iganga	Ngora	Gulu	Otuke	Kanungu	Rubirizi
Luweero	Wakiso	Jinja	Pallisa	Kaabong	Oyam	Kasese	Rukungiri
		Kaberamaido	Serere	Kitgum	Pader	Kibaale	Sheema
		Kaliro	Sironko	Koboko	Yumbe		
		Kamuli	Soroti	Kole	Zombo		
		Kapchorwa	Tororo				

4	Was the place where you were born a rural or urban area? *If unsure write down the place name*	0=rural 1=urban 2=semi-rural or peri-urban 98=Don't know 99=Refused	
5	How long have you been living in Kampala? ***Enumerator: Explain that we want to know how long they have lived in Kampala?***	1=less than 6 months 2=more than 6 months but less than 5 years 3=more than 5 years but less than 10 years 4=more than 10 years 98=Don't know 99=Refused	
6	How long have you lived in your current house in Kampala? ***Enumerator: Explain that we want to know how long they have lived in the same location in Kampala?***	1=less than 6 months 2=more than 6 months but less than 5 years 3=more than 5 years but less than 10 years 4=more than 10 years 98=Don't know 99=Refused	
7	What best describes your housing situation?	1=I have a home on land that I inherited or purchased with title 2= I have a home on land that I inherited or purchased, but no title 3=I have a home that I rent 4=I have a home but I am not paying rent (squatting) 5=I have a home but I am not paying rent (live with others (family members or friends)) 96=Other (specify) 98=Don't know 99=Refused	
8	What is the primary construction material of the roof of the dwelling? ***CHOOSE AN ANSWER BASED ON WHAT YOU OBSERVE. If someone is homeless, ask about the roof material of where they slept last night.***	1=Thatch/straw, mud, wood, or other 2=Iron sheets 3=Tiles 96=Other (specify)	
9	What is the primary construction material of the external walls of the dwelling? ***CHOOSE AN ANSWER BASED ON WHAT YOU OBSERVE.***	1=un-burnt bricks, mud and poles, thatch/straw, bamboo, timber, stone, burnt bricks with mud, other. 2=iron (or other metal) sheets. 3=burnt bricks with cement, or cement blocks 96=Other (specify)	

10	What is the main source of lighting in your dwelling?	1=Firewood 2=Candle or wax 3=Paraffin lantern 4=Electricity (grid, generator, solar) 98=Don't know 99=Refused	
11	What is the most common cooking fuel used in this household?	**[SELECT ONE]** 1= Wood; 2= Charcoal; 3= Gas or biogas; 4= Electricity; 5= Kerosene/paraffin; 6= Other, specify… 98=Don't know 99=Refused	
12	What is the type of toilet that is mainly used in your household?	**[SELECT ONE]** 0=None or bush 1=Pit latrine public (for all) 2=Pit latrine communal (compound only) 3=Pit latrine private 4=Flush toilet communal 5=Flush toilet private 98=Don't know 99=Refused	
13	What is the MAIN source of water for drinking for your household? ***Note to enumerators: this refers to the source of drinking water that is MOST commonly used by members of household.***	**[SELECT ONE]** 1=Private tap 2=Public tap 3=Water channel, stream, or pond 4=Bore-hole, well, or spring 5=Delivery (e.g. from water tank) 96=Other (specify) 98=Don't know 99=Refused	
14	***"Now I am going to ask you about some other household items. Please let me know if these items are available to your household and how many of each of them"*** Does any member of your household currently own any of the following assets?	**[SELECT ALL THAT APPLY]** 1= Car/truck 2= Motorcycle/ Boda 3= Bicycle 4= Basic Phone 5= Smart phone 6=TV 7=Radio 8=CD/DVD player 9=laptop/pc 10=Sewing machine 11= Stove for cooking (gas or electric only) 12= Built in kitchen sink 13= Refrigerator/freezer 14= Washing machine 15= Wooden cart or wheelbarrow 16= Plough 17=Solar panel 96= Others assets (worth more than approx. 130K UGX purchasing price), specify 98=Don't know 99=Refused	
15	What are the household sources of income?	**[SELECT ALL THAT APPLY]** 1=urban agriculture 2=formal business (e.g. trader, industrialist) 3=informal business (e.g. vendors, hawkers) 4=salaried employment (e.g. teacher) 5=relative/friends outside of household 96=other (specify) 99-refused	

16	Which is the primary source of income?	1=urban agriculture 2=formal business (e.g. trader, industriatlist) 3=informal business (e.g. vendors, hawkers) 4=salaried employment (e.g. teacher) 5=relative/friends outside of household 96=other (specify) 99-refused	
17	Occupation respondent	**[SELECT ALL THAT APPLY]** 1=housewife 2=urban farmer 3=formal business (e.g. trader, industrialist) 4=informal business (e.g. vendors, hawkers) 5=salaried employment (e.g. teacher) 6=relative/friends outside of household 96=other (specify) 99-refused	
18	How much money did you spend on food in the past week? ***Enumerator: Don't say the numbers out loud, just fill in the right bracket for what people say. If people find it difficult to estimate, help them.***	**[SELECT ONLY ONE]** 0=nothing 1= <20.000 UGS 2=20.000 to 40.000 UGS 3=40.000 to 100.000 UGS 4=100.000 to 200.000 UGS 5= >200.000 UGS 99=refuse	

3. Food consumption and Security

1	What do you think is essential for a healthy diet?	*Open Question (record answer)*	
2a	How do you feel about the amount of your family's consumption of fruits and vegetables in the past four weeks?	1=Plenty, enough for a healthy diet 2=Not always as much as I would have liked 3=Too little 98=Don't know 99=refuse	
2b	Why do you think that?	*Open Question (record answer)*	
3	If you think something is missing in your diet, what do you think it is?	*Open Question [write answer]*	
4	If you could add something to your diet, what would that be?	*Open Question [write answer]*	
5	Why are you not including it in your diet right now?	1= I don't have the money (no access) 2= It is not available 3= It is not the right season 4= I am not allowed (because of my clan) 96= Other (specify)	

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	Was the day before a celebration in the community?	0=no 1=yes	
2	Was there a celebration in the family yesterday?	0=no 1=yes	
3	Was the index child sick yesterday?	0=no 1=yes	
4	Were you sick yesterday?	0=no 1=yes	
5	Are you currently fasting?	0=no 1=yes	

3B. Dietary Diversity - INDIVIDUAL 24 RECALL (Consumption & Utilisation)

"Please describe the foods (meals and snacks) that you ate or drank yesterday during the day and night, whether at home or outside the home. Start with the first food or drink of the morning. Write down all foods and drinks mentioned.

Enumerators:

1. ***When composite dishes are mentioned, ask for the list of ingredients.***
2. ***When the respondent has finished, probe for meals and snacks not mentioned, these so called 'ghost' foods are written down also, but marked that they needed extra probing: Ask for:***
    a. ***Chocolates and sweets***
    b. ***Snacks in or outside the house such as samosa's or chappatis***
    c. ***Fruits***
    d. ***Sodas***

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	Is the currently mother pregnant?	1=Yes 2=No 98=Don't know 99=Refused	
2	Is the mother currently breastfeeding?	1=Yes 2=No 98=Don't know 99=Refused	

Individual 24-hr recall MOTHER

Meal time	**Name of food/dish/drink**	**Prepared by:** 1= Me 2= Somebody else in HH 3= I bought it prepared/was given	**Cooking method:** 1= Raw 2= Steamed 3= Boiled 4= Fried 5= Roasted	**ALL Ingredients/Food Item** A= Sugar B= Onions C= Garlic D= Salt E= Muchuzi mix etc F= Tomatoes G= Green pepper H= OTHERS, SPECIFY!	**Source (for each ingredient):** 1= Home garden 2= Own production village 3= Collected it (or hunted/fished) 4= I bought it from a friend/neighbour 5= Bought it at a market, supermarket, shop 6= Gift from neighbour/relatives 96= Other, specify

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	*In case the mother ate fruit yesterday:*	1=Yes 2=No (Go to Q2)	
	What type(s) of fruits did you consume yesterday?		
	How many pieces of each fruits did you consume yesterday?		
	Where did the fruits come from?	1=home garden 2=own production village 3=collected it (or hunted/fished) 4= I bought it from a friend/neighbour 5= bought it at a market, supermarket, shop 6=Gift from neighbour/relatives 96=Other, specify	
2	If you did not consume fruit(s) yesterday what are the reasons??	1=Not available during this season (on farm/ or not purchased from market)? 2=Too expensive/we cannot afford to buy 3=Personal preference (I don't like fruits) 4=Fruits are not important 5=Fruit is for the children only	

Individual 24-hr recall INDEX CHILD

Enumerator: Choose a child between 2-5 years old who is present. Actively involve the child in remembering as he/she may have had snacks and fruits, the mother or caretaker is not aware of.

NAME OF CHILD:		DATE OF BIRTH								
Gender			D	D	M	M	Y	Y	Y	Y
Age										
Still breastfed?	0=No 1=Yes									

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Individual 24-hr recall INDEX CHILD

Meal time	**Name of food/dish/drink**	**Prepared by:** 1= Me 2= Somebody else in HH 3= I bought it prepared/was given	**Cooking method:** 1= Raw 2= Steamed 3= Boiled 4= Fried 5= Roasted	**ALL Ingredients/Food Item** A= Sugar B= Onions C= Garlic D= Salt E= Muchuzi mix etc F= Tomatoes G= Green pepper H= OTHERS, SPECIFY!	**Source (for each ingredient):** 1= Home garden 2= Own production village 3= Collected it (or hunted/fished) 4= I bought it from a friend/neighbour 5= Bought it at a market, supermarket, shop 6= Gift from neighbour/relatives 96= Other, specify

Fruit consumption

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	*In case the child ate fruit yesterday:*	1=Yes 2=No (Go to Q2)	
	What type(s) of fruits did you consume yesterday?		
	How many pieces of each fruits did you consume yesterday?		
	Where did the fruits come from?	1=home garden 2=own production village 3=collected it (or hunted/fished) 4= I bought it from a friend/neighbour 5= bought it at a market, supermarket, shop 6=Gift from neighbour/relatives 96=Other, specify	
2	If you did not consume fruit(s) yesterday what are the reasons??	1=Not available during this season (on farm/ or not purchased from market)? 2=Too expensive/we cannot afford to buy 3=Personal preference (I don't like fruits) 4=Fruits are not important 5=Fruit is for the children only	

Child Health

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	Has the child received a Vitamin A capsule in the last 6 Months?	1=Yes 2=No 3= I don't know	
2	Has the child been dewormed in the last 3 Months?	1=Yes 2=No 3= I don't know	
3a	Has the child had any fever in the past 2 weeks?	1=Yes 2=No 3= I don't know	
3b	How many days out of 14?	….days	
4a	Has the child had diarrhea in the past 2 weeks?	1=Yes 2=No 3= I don't know	
4b	How many days out of 14?	….days	

4. Food security

4B Household Food Insecurity (HFIAS) (Accessibility)[1]

"I am now going to ask you questions about your household's access to food supply over the past four weeks. Food supply includes staples ("foods"), sauces, fruits, snacks, drinks and any other foods in your diet and the diets of all members of your household in the past four weeks."

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	In the past four weeks, did you ever WORRY that your household would not have enough food?	0=Never 1=Rarely (once or twice in the past four weeks) 2= Sometimes (three to ten times in the past four weeks) 3= Often (more than ten times in the past four weeks)	
2	In the past four weeks, were you or any household member NOT ABLE TO EAT THE KINDS OF FOODS YOU PREFERRED because of a lack of resources?	0=Never 1=Rarely (once or twice in the past four weeks) 2= Sometimes (three to ten times in the past four weeks) 3= Often (more than ten times in the past four weeks)	
3	In the past four weeks, did you or any household member have to eat a LIMITED VARIETY of foods due to lack of resources?	0=Never 1=Rarely (once or twice in the past four weeks) 2= Sometimes (three to ten times in the past four weeks) 3= Often (more than ten times in the past four weeks)	
4	In the past four weeks, did you or any household member HAVE TO EAT SOME FOODS THAT YOU REALLY DID NOT WANT TO EAT because of a lack of resources to obtain other types of food?	0=Never 1=Rarely (once or twice in the past four weeks) 2= Sometimes (three to ten times in the past four weeks) 3= Often (more than ten times in the past four weeks)	
5	In the past four weeks, did you or any household member have to EAT A SMALLER MEAL THAN YOU FELT YOU NEEDED because there was not enough food?	0=Never 1=Rarely (once or twice in the past four weeks) 2= Sometimes (three to ten times in the past four weeks) 3= Often (more than ten times in the past four weeks)	
6	In the past four weeks, did you or any other household member have to eat FEWER MEALS in a day because there was not enough food?	0=Never 1=Rarely (once or twice in the past four weeks) 2= Sometimes (three to ten times in the past four weeks) 3= Often (more than ten times in the past four weeks)	
7	In the past four weeks, WAS THERE EVER NO FOOD AT ALL IN YOUR HOUSEHOLD because of lack of resources to get food?	0=Never 1=Rarely (once or twice in the past four weeks) 2= Sometimes (three to ten times in the past four weeks) 3= Often (more than ten times in the past four weeks)	

[1] *(Based Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide – FANTA 3, 2007) and HFS designed by Maxwell for Kampala specifically.*

8	In the past four weeks did you or any household member have to borrow money or food due to a lack of resources?	0=Never 1=Rarely (once or twice in the past four weeks) 2= Sometimes (three to ten times in the past four weeks) 3= Often (more than ten times in the past four weeks)	
9	In the past four weeks, did you or any household member GO TO SLEEP AT NIGHT HUNGRY because there was not enough food?	0=Never 1=Rarely (once or twice in the past four weeks) 2= Sometimes (three to ten times in the past four weeks) 3= Often (more than ten times in the past four weeks)	
10	In the past four weeks, did you or any household member go a whole day and night WITHOUT EATING anything because there was not enough food?	0=Never 1=Rarely (once or twice in the past four weeks) 2= Sometimes (three to ten times in the past four weeks) 3= Often (more than ten times in the past four weeks)	

4C. Months of Inadequate Household Food Provisioning (MIHFP)

"I will now ask you about your food supply in the past year, this also includes staples, sauces and any other foods in your diet and the diets of all members of your household".

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	Were there Months in the past 12 Months in which you did not have enough food to meet your family's needs?	0=no (skip to next section) 1=yes	
1b	If yes, which were the months in the past 12 months during which you did not have enough food to meet your family's needs? ***To enumerator: This includes any kind of food from any source, such as own production, purchase or exchange, food aid, or borrowing. Do not read the list of months aloud. Use a seasonal calendar if needed to help the respondent remember the different months. Probe to make sure the respondent has though about the entire past 12 months. Check all that apply for food insecurity.***	**[Select all that apply]** 1=January 2=February 3=March 4=April 5=May 6=June 7=July 8=August 9=September 10=October 11=November 12=December	

4B Food Frequency Index Fruits & Vegetables

"In the past 7 days how often have <u>you or anyone in your household</u> consumed the fol

SN	TYPES OF FOOD	Almost every day	3-4 per wee k	1-2 per week	<1 per week (eg 1 every 2 weeks	Never	K n o w s	Ever eaten	Com
1	**VITAMIN A RICH VEGETABLES & TUBERS**								
	Carrots								
	Orange flesh sweet potato								
	Pumpkin								
2	**DARK GREEN LEAFY VEGETABLES**								
	Ebugga (*Amaranthus lividus* - red)								
	Doodo (Amaranthus dubius)								
	Ensugga 2 Broad leaved nightshade (*S. scabrum*)								
	Nakati (African Nightshade *Solanum aethiopicum*)								
	Ensugga (*S. nigrum*, Black nightshade)								
	Sukuma wiki (African kale)								
	Spinach (Spinach)								
	Cassava leaves								
	Okra								
	Essunsa (Pumpkin Leaves)								
	Timpa (Yam (obukupa) Leaves)								
	Ejjobyo (African Spiderplant *Gynandropsis (Cloeme) gynandra)*								
	Eggobe (Cow pea leaves)								
	Enderema (Vine spinach)								
	Crotalaria (Slenderleaf)								
	Sweet potato leaves (*Ipomea batatas)*								
	Moringa oleifera leaves								
	Other:								

SN	TYPES OF FOOD	Almost every day	3-4 per week	1-2 per week	<1 per week (eg 1 every 2 weeks	Never	Knows	Ever eaten	Comments
3	**OTHER VEGETABLES**								
	Biringanya (Egg plants (purple)								
	Ntula fruit (African egg plants (white or green))								
	Kutunkuma fruit (African egg plant)								
	Beetroot								
	Cabbage								
	Broccoli								
	Cauliflower								
	Zucchini/Courgette								
	Mushroom								
	Tomatoes								
	Onions								
	Bell peppers (green, red, yellow)								
	Cucumber								
	Other:								
4	**VITAMIN A RICH FRUITS**								
	Ripe mangoes								
	Pawpaws								
	Watermelon								
	Mapeera (Guava) red/orange								
5	**OTHER FRUITS**								
	Citrus (e.g. Oranges, Tangerines, limes)								
	Butunda (Passion fruit)								
	Pineapples								
	Avocado								
	Mapeera (Guava) white								
	Sweet banana (Ndizi etc)								
	Jambula (Java plum/black plum)								
	Empafu (African elemi)								

SN	TYPES OF FOOD	Almost every day	3-4 per week	1-2 per week	<1 per week (eg 1 every 2 weeks	Never	Knows	Ever eaten	Comments
	Amatugunda (*Vangueria acutiloba*, Spanish Tamarind)								
	Ntuntunu (Goose berries)								
	Enkenene (Raspberries)								
	Kamunye *(Hoslundia opposita, orange bird berry)*								
	Obutunda obukaluba (hard passion fruit)								
	Ebinyanya (tree tomato)								
	Nkomamawanga (pomegranate)								
	Kitaferi (Custard apple)								
	Ginger Lily *(Aframomum Sp)*								
	Nsusuti (*Syzygium)*								
	Muzinda (breadfruit)								
	Jack fruit								
	Tamarind								
	Munyamazi (Black plum, *Vitex doniana*)								
	Other:								
6	**INSECTS**								
	Grasshoppers, white ants, snails, grubs or other insects								
7	**SWEETS**								
	Sweets such as chocolates, sweets, candies, pastries, cakes or biscuits								
	Soda, Safi, packed sugary drinks								
	Sugar								
	Honey								
8	**MISCELLENEOUS**								
Processed foods such as crisps, chips, hamburgers, fried chicken etc.									

4C Food Sources

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	Where did you get the foods for your household in the last 4 weeks?	**[SELECT ALL THAT APPLY]** 1=Purchase in market, stall, or shop 2=From a home garden plot 3=Receive in-kind (from family or friends) 4=Collected wild foods (e.g. dodo) 5=Collected from trash or garbage (e.g. Nakasero market) 96=Other (specify) 98=Don't know 99=Refused	
2	Where did you get MOST of the food for your household in the last 4 weeks?	**[SELECT ONLY ONE]** 1= Purchase in market, stall, or shop 2=From a home garden plot 3=Receive in-kind (from family or friends) 4=Gollected wild foods (e.g. dodo) 5=Gollected from trash or garbage (e.g. Nakasero market) 96=Other (specify) 98=Don't know 99=Refused	

5. Food knowledge and experience (Quantitative & Qualitative)

"I am going to ask you a few additional questions about your food habits and health. Please respond to the following questions about yourself."

No.	Question Text	*Codes / Skip Instructions*	Answers & Comments
6	How do you store your vegetables and fruits? ***Note to enumerator: Check this if possible, ask them to show it to you.***	**[Select all that apply]** 1= Fridge 2= In a closed cabinet 3= On a fruit/vegetable rack 4= In a sack 5= In a basket 6= On the floor 7= On a counter/table/cabinet (off the floor, but open air) 8= Other, ______	
7	What is your favorite or preferred fruit? And Why? ***Enumerators: Ask the participant to choose up to three.***	**Show all the fruit cards and ask which three fruits are their favourite.**	
8	What is your favorite or preferred vegetable? And Why? ***Enumerators: Ask the participant to choose up to three.***	**Show all the vegetable cards and ask which three vegetables are their favourite.**	
9	Do you think it is shameful or embarrassing to grow your own food? ***This includes fruits and vegetables***	0=no 1=yes 98=don't know 99=refused	
10	Do you think it is shameful or embarrassing to collect foods from the wild? ***This includes fruits, vegetables and insects***	0=no 1=yes 98=don't know 99=refused	

FINAL SECTION: CONCLUDING QUESTION

Enumerator: "Thank you very much for your participation in this research project! We have just one last question."

No.	Question Text	Answers & Comments
1	Is there anything else that you'd like to tell me about what we've talked about today? 1=Yes (continue)	

Survey Code:

Protocol Collection Household and Dietary Survey (Part 3)

This part of the survey covers the final household visit. It includes:

- **A few additional HH questions for the poverty index**
- **Second 24hr-recall with Child Present!**
- **Re-asking the wild food collection questions.**
- **Antropomorphic measurements**

Make sure you interview the same person as on the previous visit (otherwise the 24-hr recall is not consistent). In a few cases we want to ask the mother if that is possible, as she may be a better person to ask these questions to, and this will make it easier for later analysis. Also mothers are generally more food insecure (thus (more) malnourished) then men.

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	Enumerator(s)	**Name**	
2	Date & Time of Interview	Date:	Time:
3	*Please remind the household about the study and ask if you can continue*		
4	Enumerator: Is the listed household available for interview?	0= Yes, and they are available to continue (>>continue) 1= Yes, but they are not home or available to continue at time of visit (>>Ask if another time is more convenient and make an appointment then go to next on the list) 2= No, they refused (>>end survey and go to next on the list) 3= No, there is nobody present (>>end survey and go to next on the list, try again later) 4= HH/plot not known/found (>>end survey and go to next on the list, try again later) 5= No, they moved (>>end survey and go to next on the list)	
5	*Make sure you are talking to the same person as last visit. Or the mother in a few cases where the mother wasn't interviewed before. Realise though that she will have to be asked again in another 24hr recall.*		

1. HH Information

N.	Question Text	Codes / Skip Instructions	Answers & Comments
1	Name of respondent ***Enumerator: If the respondent does not want to give the true name an alias is also fine or simply the first name. The reason is mainly to be able to address the respondent by a name and cross check later.***	[Insert name]	
2	Age of respondent (*Do you believe this age? Give estimate if refused and indicate) Especially if previous visits were unclear.*	[insert age]	
3	Who is the main caregiver of the index child?	Open Question	
4	Who is the main cook in the household?	Open Question	
5	How many rooms are in the house? *Note: observe also as much as you can.*	1= 1 2= 2 3= 3 4= 4 5= 5 6= 6 or more	
6	What are the windows made out of? *Note: Observe*	0= No windows 1= Open window with or without bars 2= Open window with wooden panels 3= Glass (with or without bars)	
7	Does the HH have tenants on the premises? And if yes, how many dwellings do you see?	0=No 2=Yes 96=other (specify) 98=Don't know/Unclear	

2. Food consumption and Security

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	Was the day before a celebration in the community?	0=no 1=yes	
2	Was there a celebration in the family yesterday?	0=no 1=yes	
3	Was the index child sick yesterday?	0=no 1=yes	
4	Were you sick yesterday?	0=no 1=yes	
5	Were you fasting yesterday?	0=no 1=yes	

2 A. Dietary Diversity - INDIVIDUAL 24 RECALL (Consumption & Utilisation)

"Please describe the foods (meals and snacks) that you ate or drank yesterday during the day and night, whether at home or outside the home. Start with the first food or drink of the morning. Write down all foods and drinks mentioned."

Enumerators:

1. ***When composite dishes are mentioned, ask for the list of ingredients.***
2. ***When the respondent has finished, probe for meals and snacks not mentioned, these so called 'ghost' foods are written down also, but marked that they needed extra probing: Ask for:***
   a. ***Chocolates and sweets***
   b. ***Snacks in or outside the house such as samosa's or chappatis***
   c. ***Fruits***
   d. ***Sodas***

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	Is the currently RESPONDENT pregnant?	1=Yes 2=No 98=Don't know 99=Refused	
2	Is the RESPONDENT currently breastfeeding?	1=Yes 2=No 98=Don't know 99=Refused	

Individual 24-hr recall MOTHER/RESPONDENT

Meal time	**Name of food/dish/drink**	**Prepared by:** 1= Me 2= Somebody else in HH 3= I bought it prepared/was given	**Cooking method:** 1= Raw 2= Steamed 3= Boiled 4= Fried 5= Roasted	**ALL Ingredients/Food Item** A= Sugar B= Onions C= Garlic D= Salt E= Muchuzi mix etc F= Tomatoes G= Green pepper H= OTHERS, SPECIFY!	**Source (for each ingredient):** 1= Home garden 2= Own production village 3= Collected it (or hunted/fished) 4= I bought it from a friend/neighbour 5= Bought it at a market, supermarket, shop 6= Gift from neighbour/relatives 96= Other, specify

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	*In case the respondent ate fruit yesterday:*	1=Yes 2=No (Go to Q2)	
	What type(s) of fruits did you consume yesterday?		
	How many pieces of each fruits did you consume yesterday?		
	Where did the fruits come from?	1=home garden 2=own production village 3=collected it (or hunted/fished) 4= I bought it from a friend/neighbour 5= bought it at a market, supermarket, shop 6=Gift from neighbour/relatives 96=Other, specify	
2	If you did not consume fruit(s) yesterday what are the reasons?	1=Not available during this season (on farm/ or not purchased from market)? 2=Too expensive/we cannot afford to buy 3=Personal preference (I don't like fruits) 4=Fruits are not important 5=Fruit is for the children only	

Individual 24-hr recall INDEX CHILD

Enumerator: Choose a child between 2-5 years old who is present. Actively involve the child in remembering as he/she may have had snacks and fruits, the mother or caretaker is not aware of. ASK TO SEE THE BIRTHCARD OF THE CHILD TO CONFIRM BIRTHDATE. In case there is no birth card try actively remember with the respondent what the birthday is.

NAME OF CHILD:		DATE OF BIRTH								
Gender			D	D	M	M	Y	Y	Y	Y
Age										
Still breastfed?	0=No 1=Yes	Have you seen the BIRTHCARD?	0=No 1=Yes							

Individual 24-hr recall INDEX CHILD

Meal time	**Name of food/dish/drink**	**Prepared by:** 1= Me 2= Somebody else in HH 3= I bought it prepared/was given	**Cooking method:** 1= Raw 2= Steamed 3= Boiled 4= Fried 5= Roasted	**ALL Ingredients/Food Item** A= Sugar B= Onions C= Garlic D= Salt E= Muchuzi mix etc F= Tomatoes G= Green pepper H= OTHERS, SPECIFY!	**Source (for each ingredient):** 1= Home garden 2= Own production village 3= Collected it (or hunted/fished) 4= I bought it from a friend/neighbour 5= Bought it at a market, supermarket, shop 6= Gift from neighbour/relatives 96= Other, specify

Fruit consumption

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	*In case the child ate fruit yesterday:*	1=Yes 2=No (Go to Q2)	
	What type(s) of fruits did you consume yesterday?		
	How many pieces of each fruits did you consume yesterday?		
	Where did the fruits come from?	1=home garden 2=own production village 3=collected it (or hunted/fished) 4= I bought it from a friend/neighbour 5= bought it at a market, supermarket, shop 6=Gift from neighbour/relatives 96=Other, specify	
2	If you did not consume fruit(s) yesterday what are the reasons?	1=Not available during this season (on farm/ or not purchased from market)? 2=Too expensive/we cannot afford to buy 3=Personal preference (I don't like fruits) 4=Fruits are not important 5=Fruit is for the children only	

Child Health

No.	Question Text	Codes / Skip Instructions	Answers & Comments
1	Has the child received a Vitamin A capsule in the last 6 Months?	1=Yes 2=No 3= I don't know	
2	Has the child been dewormed in the last 3 Months?	1=Yes 2=No 3= I don't know	
3a	Has the child had any fever in the past 2 weeks?	1=Yes 2=No 3= I don't know	
3b	How many days out of 14?	….days	
4a	Has the child had diarrhea in the past 2 weeks?	1=Yes 2=No 3= I don't know	
4b	How many days out of 14?	….days	

3. Food Sources

3 A. (Food) Products <u>SENT</u> from the <u>VILLAGE</u> in the past season (6 months), these include common crops as well as "wild" ones.					
Product group	**Species** *List them, and fill in the table for each of them*		**Which Months?**	**How often in those months?** 1=almost every day; 2=3-4 times per week; 3=1-2 per week; 4=<1 per week	**Purpose [All that apply]** 1=food 2=medicine 3=spiritual 4=horticulture or nursery 5=crafts decoration 6=fuel 96= Other, (specify)
Fruits					
Vegetables					
Mushrooms					
Leaves					
Honey					
Nuts					
Medicinal Plants/Herbs					
Tubers and Legumes					
Cereals					
Fish					
Edible Insects					
Wild meat (rodents etc)					

Enumerator: "Thank you, I now want to learn about you and your households experience with collecting (or foraging) products in Kampala." Try probing with what people would 'normally' collect in their village, and see if they do it here too. Also think about medicinal purposes!

3.B Products COLLECTED or FORAGED IN KAMPALA in the past 6 months.						
Product group	**Species** *List them, and fill in the table for each of them*	**Which months?**	**How often in those months?** 1=almost every day; 2=3-4 times per week; 3=1-2 per week; 4=<1 per week	**Source [All that apply]** 1=wetlands 2=public urban land (roadside, parks); 3=private land (not your own) (vacant plot, university, golf court etc) (4=from village) 96=other, specify	**Purpose_1 [All that apply]** 1=food; 2=medicine 3=spiritual 4= horticulture or nursery; 5=crafts decoration; 6=fuel; 96= Other,(specify)	**Purpose_2 [Only one]** 1=Own use & gifts 2=commercial for sale 3=both
Fruits						
Vegetables						
Mushrooms						
Leaves						
Honey						
Nuts						
Medicinal Plants/Herbs						
Tubers and Legumes						
Cereals						
Fish						
Edible Insects						
Wild meat (rodents etc)						

3.C Products COLLECTED or FORAGED OUTSIDE KAMPALA (village or otherwise) in the past 6 months						
Product group	**Species** *List them, and fill in the table for each of them*	**Which months?**	**How often in those months?** 1=almost every day; 2=3-4 times per week; 3=1-2 per week; 4=<1 per week	**Source (location(s))** **[All that apply]** 1=wetlands 2=public urban land (roadside, parks); 3=private land (not your own) (vacant plot, university, golf court etc) 4= in village 96=other, specify	**Purpose_1** **[All that apply]** 1=food; 2=medicine 3=spiritual 4= horticulture or nursery; 5=crafts decoration; 6=fuel; 96= Other,(specify)	**Purpose_2** **[Only one]** 1=Own use & gifts 2=commercial for sale 3=both
Fruits						
Vegetables						
Mushrooms						
Leaves						
Honey						
Nuts						
Medicinal Plants/Herbs						
Tubers and Legumes						
Cereals						
Fish						
Edible Insects						
Wild meat (rodents etc)						

In this context wild fruits are considered the types of food that you could collect in the wild. So fruits from a tree that is on public land. Even mangoes can be collected from the wild, although this is unknown to us when they are bought at the market. Gooseberries however are more likely to have been gathered from the wild. But we don't really know when they are bought, or sent. In this first section try to gather as much information as you can on all types of fruits and vegetables. Probe by saying "

1	**If you were in the village, some fruits, vegetables and herbs you can collect for free, please think of those and answer the following question:** Do you ever buy these in the market here?	0= No 1= Yes 98= Don't know 99= Refused
1b	And if yes, which are they?	
2	Would you ever pay for them if they were more available?	0= No 1= Yes 98= Don't know 99= Refused
2b	And if yes, which?	

3D Additional Questions on wild foods

1	I am going to give you some statements, please tell me for each one whether you agree with them or not. There are no right or wrong answers, we simply want to get an idea of how important some 'wild' products are to you and why.	**[Select all that apply]** 1=It is an important way to feed my family, especially in times of low production (insecurity/out of necessity) 2=Why would I pay, if I can collect it for free? 3=These products are not available at the market, or they are very expensive 4=I know these products from my village. 5=These products have essential nutrients for health 6=Nature is my pharmacy 7=I use them to diversify my family's diet 8=They are not healthy because of pollution. 9=They are foods for the poor 99=refused	

4. ANTROPOMORPHIC MEASUREMENTS

Index Child	
Length in cm	
Weight in Kg	

Respondent	
Length in cm	
Weight in Kg	

FINAL SECTION: CONCLUDING QUESTION

Enumerator: "Thank you very much for your participation in this research project! We have just one last question."

No.	Question Text	Answers & Comments
1	Is there anything else that you'd like to tell me about what we've talked about today? 1=Yes (continue)	

Annex 2
Kampala's Land Tenure System: a complicated issue

Until 1968 Kampala existed of two cities. Mengo, the capital of the Buganda Kingdom, and Kampala, the European and Indian settlement growing next to Mengo. The two had strongly differing political systems, evident in the existing land tenure systems. Mengo, used the *mailo* tenure system; "a form of freehold ownership under which tenants could acquire long-term occupancy rights from a landlord." (Maxwell 1995). However, in Kampala, land tenants could acquire land on the basis of leasehold, as state owned land was administered as public.

This has resulted in a complex system of land tenure systems existing in what we now call greater Kampala. The combination of the two cities as well as the various land systems introduced over the years by those in power created a system that can be described as a spectrum of legal to illegal forms of tenure. In the mid 1960s Milton Obote abolished all kingdoms, this meant that all royal lands became government owned, at least on paper. However, in 1993 these lands were officially returned to the kingdoms, which has since created issues in titles and ownership.

In short, after Uganda's land tenure reform in the Land Act of 1998, and its amendment in 2010 Uganda now has four types of tenureship: *Mailo,* freehold, leasehold and customary. Of which the latter, is non-existent in Kampala, and *mailo* is the most prevalent one (Muinde 2013).

Mailo tenureship can refer to both 'public' land owned by the Baganda kingdom and privately owned *mailo* land by individuals. The land is owned by the individual into eternity, however there is a separation between ownership of land and ownership of developments on the land by the occupants (Uganda Government 1998). The system has its roots in pre-colonial times of peasants using the king's lands (Okuku 2006). Official registration of the allotments occurred according to the 1900 Uganda Agreement (Uganda Government 1998), when land was distributed by the kingdom. The system was abolished during Obote's presidency in the late 1960s and the 1975 Land Reform Decree, however it was reinstalled in 1993. Public *mailo* land is technically still owned by the kingdom, but since these land transactions were based on longterm leasehold, they can be considered under private ownership now. However, this land is managed by the Baganda Land Board (the kingdom's own institute). Under private *mailo* ownership, the title owner is free to sell land titles or transfer title through inheritance.

Leasehold is the second most common form of land tenure in Kampala. It is public land owned by the government, managed by the Kampala District Land Board, and leased to private individuals. There is no separation between ownership of land and ownership of developments on land.

Freehold tenureship, the least common form of tenure in Kampala, includes land owned by institutions such as schools and churches. The land is owned permanently and the owner is free to develop the land as he or she pleases since there is no separation between ownership of land and ownership of developments of land as is the case in *mailo* land tenure systems.

Under the *mailo* system, there can be two levels of rights, one by the registered owner and the other by the occupant. The occupants have rights over their small portion of land, *kibanja*, and they are called *kibanja* holders. They form a significant group within Kampala (Muinde 2013). Since both *kibanja* holder (the occupant) as well as the registered owner both have rights to the land they own or occupy, causing concerns such as double ownership. In addition, there are other issues, especially when *bibanja* (plural of *kibanja*) are unregistered, such fraud, evictions and land grabbing. Therefore, Kampala has started a campaign urging *kibanja* holders to register.

In the context of this study however, we were interested in land tenure security. As high land tenure security gives people more certainty that they (or their offspring) will be able to harvest the fruits of their investments such as planted fruit trees. People are more motivated to invest in management and planting long term crops such as trees in their garden if they are certain they will be able to profit from it in the future. Land titles, ownership, leaseholds and proof of registration all form a sense of land tenure security. Someone who rents or squats on a piece of land is more likely to only plant fast growing crops to ensure they receive a return on their investment of buying seeds and planting them. Since land occupancy such as *kibanja* are considered long term agreements, people can be considered fairly secure, however they are less secure then full owners such as *mailo* and freehold. In this study, we categorised households into two levels of security only: those that have limited to no security (squatters and renters), and *kibanja* holders, freehold and *mailo* owners. The reason for this was that even after probing and repeated questioning, the answers to this question remained unreliable. Many respondents were unsure about the exact status of their 'ownership' situation. However, in the end it proved that since <4% of our respondents had at least a long-term agreement on their land, and thus exhibited a fair degree of tenure security, this issue as a variable could not be tested in our analyses. However, it proves its own point as through our purposive sampling strategy all households that actually have a garden also are more tenure secure.