PERI-URBAN AGROFORESTRY AS A SOURCE OF LIVELIHOOD: CASE STUDY ON FRUIT TREES IN DZIVARASEKWA IN HARARE, ZIMBABWE

Heidi Haavisto-Meier
Master Thesis
University of Helsinki
Department of
Agricultural Sciences
Agroecology
2018

HELSINGIN YLIOPISTO — HELSINGFORS UNIVERSITET — UNIVERSITY OF HELSINKI

Tiedekunta/Osasto — Fakultet/Sektion — Faculty	Laitos — Institution — Department	
Maatalous-metsätieteellinen tiedekunta	Maataloustieteiden laitos	
Tekijä — Författare — Author		
Heidi Haavisto-Meier		
Työn nimi — Arbetets titel — Title		
Peri-urban agroforestry as a source of livelihood: case study on fruit trees in Dzivarasekwa in Harare, Zimbabwe		
Oppiaine —Läroämne — Subject		
Agroekologia		
Työn laji — Arbetets art — Level	Aika — Datum — Month and year	Sivumäärä — Sidoantal — Number of pages
Maisterintutkielma	Marraskuu 2018	72 s.

Tiivistelmä — Referat — Abstract

Tiheään asutuilla alueilla ruoantuotannon on sopeuduttava kasvavan väestön ja kaupungistumisen tuomiin haasteisiin. Tämä koskee eritoten Afrikkaa, jossa väestönkasvu seuraavan 30 vuoden aikana tulee olemaan suurempaa kuin muissa maanosissa. Tästä johtuen kaupunkia ympäröivän peltometsäviljelyn odotetaan olevan tärkeässä roolissa tulevaisuudessa tällä alueella. Kotipuutarhat, jotka ovat osa peltometsäviljelyä, on nähty yhtenä ratkaisukeinona parantaa ihmisten ruoka- ja ravitsemusturvaa. Hedelmäpuut tarjoavat kotitalouksille vaihtelua päivittäiseen ruokavalioon. Hedelmät sisältävät vitamiineja ja muita ravintoaineita, jotka tutkitusti auttavat sairauksien ehkäisyssä. Lisäksi hedelmien myynti voi tarjota kotitalouksille myös tulonlähteen.

Tässä tutkimuksessa selvitettiin Dzivarasekwan kehysalueella Hararessa Zimbabwessa, mitä hedelmäpuita ihmiset kasvattavat kotipuutarhoissa. Tutkimuksessa selvitettiin, miten kotitaloudet käyttävät hedelmäpuista saatavan sadon, myyvätkö he sen vai käyttävät osana päivittäistä ravitsemusta. Aineisto kerättiin haastattelemalla paikallisia heidän kotipuutarhoissaan syksyllä 2015. Haastatteluja tehtiin 34 ja viidestä kotipuutarhasta piirrettiin kuvailevat kartat.

Tutkimuksessa havaittiin yhteensä 16 erilaista hedelmäpuuta, joista yleisimpiä olivat avokado, mango, guava ja persikka. Myös neljä kotoperäistä hedelmäpuulajia kasvoi alueen kotipuutarhoissa. Haastateltavista kotitalouksista kaikki käyttivät hedelmiä osana ravitsemusta ja kahdeksan kotitaloutta lisäksi myi hedelmiä lisätuloja saadakseen. Suurin rajoittava tekijä hedelmäpuiden kasvatuksessa oli kotipuutarhojen pieni koko. Ihmiset olivat kuitenkin kiinnostuneita kasvattamaan lisää hedelmäpuita, myös kotoperäisiä, jos heillä olisi taimia ja riittävästi tilaa. Kotitaloudet olivat kiinnostuneita myös paremmista lajikkeista. Tulokset osoittavat, että kotipuutarhoissa kasvatetut hedelmäpuut voivat tuottaa kotitalouksille hedelmiä päivittäiseen ruokavalioon ympäri vuoden. Lisäksi hedelmien myynti voi tuoda kaivattuja lisätuloja kotitaloudelle.

Avainsanat — Nyckelord — Keywords

Kehysalue, peltometsäviljely, toimeentulo, kotipuutarhatuotanto, hedelmäpuu, Zimbabwe, kotoperäinen hedelmäpuu, ravitsemusturva

Säilytyspaikka — Förvaringsställe — Where deposited

Maataloustieteiden laitos ja Viikin kampuskirjasto

Muita tietoja — Övriga uppgifter — Further information

Työn ohjaajat: Juha Helenius, Olavi Luukkanen

HELSINGIN YLIOPISTO — HELSINGFORS UNIVERSITET — UNIVERSITY OF HELSINKI

Tiedekunta/Osasto — Fakultet/Sektion — Faculty	Laitos — Institution — Department	
Faculty of Agriculture and Forestry	Department of Agricultural Sciences	
Tekijä — Författare — Author		
Heidi Haavisto-Meier		
Työn nimi — Arbetets titel — Title		
Peri-urban agroforestry as a source of livelihood: case study on fruit trees in Dzivarasekwa in Harare, Zimbabwe		
Oppiaine —Läroämne — Subject		
Agroecology		
Työn laji — Arbetets art — Level	Aika — Datum — Month and year	Sivumäärä — Sidoantal — Number of pages
Master's thesis	November 2018	72 p.

Tiivistelmä — Referat — Abstract

Food production in densely populated areas needs to adjust to the pivotal challenges of an increasing population and urbanization. Particularly, this applies for Africa, which will face the highest population growth of all continents within the next 30 years. This is why in the future peri-urban agroforestry is expected to play a more important role in this area of the world. Homegardens which are part of agroforestry systems are seen as one of the ways to improve people's food security and nutrition security. For households fruit trees offer a variety for the daily diet. Besides the fact that fruits contain various vitamins and other nutrients which help to prevent diseases, selling fruits can additionally offer a source of income for some households.

This study found out what kind of fruit tree species people are growing in their homegardens, in the peri-urban area of Dzivarasekwa (Harare), Zimbabwe. The study investigated how households use fruits whether they sell them or use them as a part of daily nutrition. The material was collected by interviewing local people in their homegardens in the fall of 2015. 34 interviews were conducted and 5 descriptive maps of homegardens were drawn.

The study found in total 16 different fruit trees, from which the most common were mango, avocado, guava and peach. Also 4 different indigenous fruit tree species were grown in the homegardens. From the interviewed households all of them used fruits as a part of nutrition and eight households also sold fruits to get income. The strongest limiting factor in the cultivation of fruit trees was the small size of the homegardens. However, people would be interested to grow more fruit trees, even indigenous ones, if they had the seedlings available and enough space. People were also interested in better varieties if they would be available. The results show that fruit trees grown in the homegardens can produce fruits for the household for the daily diet all over the year. In addition, fruit sales can bring an extra income for the households.

Avainsanat — Nyckelord — Keywords

Peri-urban, agroforestry, livelihood, homegarden, fruit tree, Zimbabwe, indigenous fruit tree, nutrition security

Säilytyspaikka — Förvaringsställe — Where deposited

Department of Agricultural Sciences and Viikki Campus Library

Muita tietoja — Övriga uppgifter — Further information

Supervisors: Juha Helenius, Olavi Luukkanen

ACKNOWLEDGEMENT

This study was part of Dzikwa Trust Fund Reforestation project. The project was implemented in cooperation with the University of Helsinki/Tropical Resources Institute (VITRI), Finnish Ministry of Foreign Affairs and Bindura University. Finnish Ministry of Foreign Affairs granted a fund to the Zimbabwe Aids Orphans Society which enabled this study to be carried out.

I want to thank many people who helped me during the planning, data collection in Zimbabwe and writing process. I want to thank my two supervisors Juha Helenius and Olavi Luukkanen from University of Helsinki, who gave me priceless help during the planning and writing process of the thesis. Many thanks also to Oili Wuolle and Seppo Ainamo who were helping me during the data collection in Zimbabwe. I feel privileged when I got this opportunity to collect my data part of this project. I also want say big thanks to Joseph Pilime from the Bindura University who worked as my interpreter during all the interviews. Without you collecting the data would have not been so easy.

I received a grant for my thesis from the Suoma Loimaranta-Airila Fund. I humbly thank you and appreciate it.

Finally, I also want to thank my husband Marius, for all his support during this long process. Your help was invaluable.

Helsinki, November 2018

Heidi Haavisto-Meier

CONTENTS

ACKNOWLEDGEMENT **4**
CONTENTS **5**
LIST OF AGRONYMS AND ABBREVIATIONS **7**
1 INTRODUCTION **8**
2 AIMS OF THE STUDY **10**
3 THEORETICAL FRAMEWORK **11**
3.1 Homegarden as a form of agroforestry **11**
3.2 Peri-urban agriculture **13**
3.3 Common fruit trees in Africa **14**
3.4 Indigenous fruit trees **17**
3.5 Fruits as a part of people's livelihoods **20**
3.5.1 Cash income 20
3.5.2 Nutrition 22
3.6 Food security and nutrition security **24**
4 MATERIALS AND METHODS **27**
4.1 Study area **27**
4.2 Questionnaire **28**
4.3 Data collection **29**
4.4 Analyzing data **30**
5 RESULTS **32**
5.1 Size of the households and homegardens **32**
5.2. Fruit trees grown **34**
5.2.1 Number of fruit trees 34
5.2.2 Fruit tree species 35
5.2.3 Indigenous fruit trees 38
5.2.4 Seeds and seedlings 39
5.2.5 Fruit yield 40
5.2.6 Future aspects 40
5.2.7 Limiting factors 40
5.3 Other species and investment to homegarden products **41**

5.4 Fruits as part of livelihood 42
5.4.1 Part of nutrition 43
5.4.2 Part of income 43
5.4.3 Part of other usage 44
5.5 Descriptive maps of homegardens 44
6 DISCUSSION 50
6.1 The role of fruit trees in improving livelihoods 50
6.2 Indigenous fruit trees as part of agroforestry systems 54
7 CONCLUSIONS 56
REFERENCES 57
ANNEX 1 MAP OF THE RESEARCH AREA 65
ANNEX 2 QUESTIONNARY 66
ANNEX 3 FRUIT TREE SPECIES MENTIONED IN THE INTERVIEWS 70
ANNEX 4 INDIGENOUS TREE SPECIES THAT PROVIDE EDIBLE FRUITS 71

LIST OF AGRONYMS AND ABBREVIATIONS

FAO	Food and Agricultural Organization of the United Nations
IFT	Indigenous Fruit Tree
SSA	Sub-Saharan Africa
UN	United Nations
UPA	Urban and Peri-urban agriculture

1 INTRODUCTION

According to the United Nations (2015) the world population is expected to be 9 billion people in 2050. More than half of this growth will happen in Africa where the population will grow from 1.19 billion in 2015 to 2.48 billion in 2050 (UN 2015). At the same time also food production needs to increase (Galhena et al. 2013). In the future, African agriculture will face a major challenge when more food needs to be produced for the growing population while fighting against hunger and poverty (Garrity et al. 2010). The population in sub-Saharan Africa is also expected to grow in the future and this will lead to starvation under current circumstances. In the future, these countries need to produce more food than they produce at the moment. There is already low income, food insecurity and malnutrition in most of the Southern African countries among the peri-urban and rural people (Akinnifesi et al. 2004).

In Africa trees positively affect the food security. They are part of farming livelihoods and offer social and environmental benefits. In the last decades, the food situation in Africa has become worse because of a lack of effective agricultural solutions and land degradation. The lack of food supply leads to an increased interest in agroforestry systems (Mbow et al. 2014). Thus, studies found that in sub-Saharan African countries, food security depends often on local food production (Ward 2011). In declining economies homegardens constitute a more and more important source of food (FAO 2001). Therefore, attention has been paid to homegardens as a way of improving household nutrition and food security in these areas of the world (Galhena et al. 2013). One of the main benefits of agroforestry for small holders is that it provides products for both home consumption and sale (Mbow et al. 2013).

A homegarden is a type of agroforestry system (Kumar and Nair 2006). In homegarden production, different kind of trees, bushes and crops are cultivated in privately owned gardens, so that people practicing this kind of food production benefit in both food supply and income generation (Kumar and Nair 2004). Still, the main point of the homegarden is home consumption. Thus, one purpose of homegardening is that people do not need to rely so much on rice and maize that they buy in most cases from local markets. People often suffer

from the deficiency of vitamins and micronutrients in their daily diet because of poor nutrition. This is so called hidden hunger. Fruits can offer vitamins, good oils, carbohydrates, minerals and antioxidants to the daily nutrition (Akinnefesi et al. 2004). According to Landon-Lane (2011) all fruits are a good source of vitamins and minerals. In peri-urban and urban homegardens fruit trees are often a very important part of the families' nutrition. By adding more fruits to a daily diet, households could improve their vitamin situation and could avoid different diseases caused by vitamin deficiencies (Akinnefesi et al. 2004; Landon-Lane 2011).

Selling fruits can also improve significantly the financial situation of the household (Venter and Witkowski 2011). This allows the household to use the incomes to satisfy their basic needs (Linger 2014). In particular, the poor households benefit from the sales of gardening products (Maroyi 2009). In addition, selling fruits can particularly improve the economic situation of women (Kiptot et al. 2014).

This study was part of Dzikwa Trust Fund Reforestation project. The research was carried out by interviewing local people who have a homegarden where fruit trees are grown in Dzivarasekwa in Harare, Zimbabwe. By interviewing people it was possible to get to know what fruit trees people are growing, how they use the yield and what are their interests towards growing and eating fruits.

2 AIMS OF THE STUDY

The aim of this study was, in the context of Harare, Zimbabwe, to find out what fruit tree species people are growing in their homegardens and how people make use of the yield of the fruit trees, for example whether they sell the fruits or eat them. Thus, the study investigated the contribution of fruit trees to the cultivation, income acquisition and nutrition. Finding out which fruit trees people are growing in their gardens and how they use them, allows to derive recommendations for action in order to improve the productivity of the agroforestry area.

The first hypothesis was that the fruits that people are growing in their homegardens are primarily for the family's own use.

The second hypothesis was that the fruit trees that are grown in the homegardens also bring the family an additional income.

The third hypothesis was that fruits which are produced in the homegardens can produce food for the family on year-round basis.

3 THEORETICAL FRAMEWORK

3.1 Homegarden as a form of agroforestry

Agroforestry is a land use system which is self-sufficient and integrated (Tauqueer et al. 2015). In this system trees, shrubs, palms and bamboos are grown in the same piece of land together with arable crops or livestock (ICRAF 2018). In agroforestry systems two or more plant species are making coherent unity and in this way are in biological interaction with each other. One of these plant species has to be a woody perennial and the other one a plant which is cultivated for crop production (Deheuvels et al. 2012). In agroforestry systems nitrogen fixation plants play an important role, because they bind nitrogen from the air and thus improve the nitrogen content in the soil (Issah et al. 2014).

Monoculture agriculture has not been as successful in Africa as in other parts of the world. Instead, agroforestry systems are more common than before. They offer many benefits for farmers and households' livelihoods. One of the best benefit of an agroforestry system to a small holder farmer is that it produces products cost-effectively both for home consumption and sale (Mbow et al. 2013). So besides ecological benefits, agroforestry system also offer economic benefits for people (Simelton et al. 2016). Agroforestry systems should play a more important role in the future since they diversify production and improve productivity (FAO 2001).

Homegardens are a form of agroforestry systems which are considered to be ecologically sustainable systems to diversify local peoples' livelihood (Kumar and Nair 2006). Together with annual or perennial arable crops there are growing trees and shrubs in homegardens. Often people have in their homegardens domestic animals as well (Linger 2014).

In urban homegardens fruit trees often play a very important role (FAO 2001). Trees can have many different kind of purposes: They can produce fruits, nuts, leaves and oil for people's nutrition as well as medicines. For livestock, trees can give fodder, fuel wood for energy production, timber and biomass. Apart from offering shade for humans, plants and livestock (ICRAF 2018), trees can

also improve the soil's structure and nutrition. Therefore, it can be said that agroforestry systems have also ecological benefits as stated above (Simelton et al. 2016).

Homegarden production is the oldest cultivation method which is practiced all over the world (Mekonen et al. 2015), already centuries as part of the local food production (Galhena et al. 2013). It is widely practiced in subtropical and tropical areas of Asia, Africa and Central and South America (Mekonen et al. 2015). In Africa homegarden production is concentrated especially to East and West Africa (Kumar and Nair 2006). Climate affects the degree of diversification of the homegardens in Africa. In humid areas there are more different species than in drier areas (Landon-Lane 2011).

Population density also affects homegardens. In more densely populated areas, homegardens are smaller than in less populated areas (Landon-Lane 2011). The area which is used for homegarden production is smaller than a conventional agricultural area, but often one can find more species. Another main difference compared to normal agroforestry systems is that homegardening can be practiced both in rural and urban areas (Landon-Lane 2011). One definition for homegarden is also that the people living in the household are taking care of the plants growing in the homegarden instead of external workers. The cultivated area is also next to the home (Atangana et al. 2014).

Homegarden systems produces food from the plants and animals, medical plants, shade, firewood and organic waste management. If the household has enough products to sell, then homegardening serves as livelihood for the household. At the same time, the household's food security and nutrition security improve because of diverse homegarden products (Mbow et al. 2013). Homegardens bring security also according to Landon-Lane (2011). During the years 2008-2010 when food prices rose, (for example in Mozambique the price of sweet potato doubled (Nawrotzki 2014)), people got fruits and vegetables from their own homegarden. Hence households managed to avoid the worst food crisis (Landon-Lane 2011). In homegardens plants and trees are often in many canopy layers, which allow plants to utilize many different layers in light

competition (Mbow et al. 2013). Homegardens are also important places to preserve vanishing plant species and to make some plant experiments (Mekonen et al. 2015).

According to Maroyi (2013) in Zvishavan area in Zimbabwe, the most important homegarden products produced were fruits and vegetables for food, medical plants and ornamentals. In this area, homegardens also produced building materials and ceremonial benefits for the households.

3.2 Peri-urban agriculture

The population in the urban areas of the world has grown fast. In 1950 there were 751 million people living in urban areas whereas in 2018 there are already 4.2 billion, which constitute 55% of the population in the world. Nowadays, already more people are living in urban areas than in rural areas. Urbanization is still an ongoing phenomenon and it is predicted that 68% of the population, by 2050, are living in urban areas. Even though in Africa there are still more people living in rural areas, most of the urbanization is projected to happen exactly in Africa and Asia by 2050 because of the increase in population (UN 2015).

Because of the fast growing cities and food insecurity in the [Global] South, there has been more interest towards peri-urban agriculture. Urban and peri-urban agriculture (UPA) is farming pursued in the surrounding boundaries of cities, but normally in farm units. These farms are semi- or fully commercials. UPA can contain horticulture, livestock production, milk and egg production, but as well fish farming and non-wood forest products. In peri-urban areas people use organic waste as compost which they then use when cultivating tree seedlings and fruit trees. Homegardening is one of the most accepted way of UPA. From continent to continent, the peri-urban agriculture varies depending on for example cultural aspects and the economic situation of the country (FAO 2001).

The idea of peri-urban horticulture is to meet the food and job requirements caused by the increasing urban population. Horticulture can even provide up to 50 kg fresh fruits and vegetables per square meter. Worldwide even 70% of the

eggs and 34% of the meat are produced in commercial peri-urban farms and this sector is still growing (FAO 2001).

It is also common to have trees and shrubs in the same area with agricultural crops or livestock especially in poor urban areas. According to FAO (2001), urban forestry programmes should ease the trend to have more fruit trees to increase the sustainability of agricultural land. Trees grown in urban and peri-urban area, can provide for example food like fruits and in this way meet better daily food requirements of the people living in these areas (FAO 2001). Agroforestry techniques of rural areas can be also adopted in urban and peri-urban areas. In general, the role of agroforestry should get more attention in the future as a way of improving productivity of the food producing trees (FAO 2001). Besides this, there are also other benefits. Carbon sequestration is one way how trees can contribute to ease the impacts of climate change (Agyapong et al. 2018).

Seasons affect UPA production, but it also reduces seasonal gaps of fresh food. When people are growing products that give yield year around or in different seasons, it brings stability of food supply. When having both horticulture and animal products, UPA improves diets through diversification. People can also sell these fresh food products in markets or on the street. People would benefit of UPA even more if people got nutrition education where they would be taught how to make use out of this food. UPA also creates employment and in this way brings income for people as well as improves the socio-economical standards (FAO 2001).

3.3 Common fruit trees in Africa

In Africa people often grow different kind of fruit trees in their homegardens (table 1). The following are common species in the tropical areas and that is a reason why they have adapted to the local climate: avocado (*Persea americana* Mill.*)*, banana (*Musa sapientum* L.), coconut (*Cocos nucifera* L.), guava (*Psidium guajava* L.), mango (*Mangifera indica* L.), papaya (*Carica papaya* L.), pineapple (*Ananas comosus* (L.) Merr.) and citrus fruits. These fruit tree species are also economically important in Africa (Rice et al. 1987).

Table 1. Common fruit tree species in Africa and their nutritional content (Rice et al. 1987; van Wyk 2006).

Fruit	Energy kcal/100g	Vitamins	Other important substances
Avocado	220	A, B1, B2, B3, B9, C	enzymes
Banana	88-100	B6, B9, C	magnesium, potassium
Coconut	370		fat, phosphorus, potassium
Grapefruit	40	A, B, C	potassium
Guava	34	A, C	phosphorus
Lemon	30	C	citric acid
Lime	30	C	
Mango	60	A, B, C	
Orange	40	A, C	potassium
Papaya	43	A, C	calcium
Pineapple	55	A, C, E	enzymes

Avocado, banana, mango, papaya and citrus fruits are fruit tree species which provide food and shade for the people who produce them in homegardens. Because it is possible to dry and conserve fruits, they provide food also out of season (Moir et al. 2007).

Avocado is one of the fruit tree species grown in Africa. It is said that avocado is the most nutrient-rich fruit (van Wyk 2006) because it contains lots of oils and proteins (Rice et al. 1987). It is normally used as a fresh product, in beverages or to make guacamole (Nagy and Shaw 1980). Like it is said in Table 1 avocado contains 220 kcal per 100g and is a rich source of vitamins B1, B2, B9, C and A, as well as iron and potassium (van Wyk 2006). In most of the areas in Africa, avocado is grown for domestic needs (Rice et al. 1987).

Bananas are common in tropical areas. They are part of peoples' staple food in many parts of Africa. The continent is also the main producer of bananas in terms of domestic production (Rice et al. 1987). Bananas are normally used as fresh, raw or cooked (Nagy and Shaw 1980). Banana contains lots minerals and vitamins but is as well a very energy (kcal/kJ) rich fruit. It came already in the 9th century from Borneo to Madagascar (van Wyk 2006).

Coconut is originally from the region of Malaysia but is nowadays found in all the tropics (van Wyk 2006), especially in coastal areas (Rice et al. 1987). From coconut it is popular to use the oily endosperm called copra of the nut from

which it is possible to get oil, flour, milk, cream or coconut meat. The endosperm is a good source of fat, sugar, potassium and phosphorus (van Wyk 2006). Also, other parts of the palm tree are often used for producing sugar, ropes, mats, building materials and coir (Rice et al. 1987).

Guava is growing widely in Africa (Rice et al 1987), but it is originally from Central America (van Wyk 2006). Guava grows in tropical areas and is an important fruit in these areas. It is used as fresh fruit, but also to make purees, juice or jellys (Nagy and Shaw 1980). Guava is one of the best sources of vitamin C, but also contains phosphorus (van Wyk 2006) and vitamin A (Rice et al. 1987).

Mango is a nutritionally important fruit because it contains lots of vitamin A, B and C (van Wyk 2006). Most mangoes in Africa are very fibrous (Rice et al. 1987). People eat the fruit flesh of the mango, but mangoes are as well used in salads and chutneys (van Wyk 2006). Mango is actually said to be the most important fruit tree in the tropical areas which is producing fruits seasonally (Rice et al. 1987). They came to Africa from India already in the 9th century (van Wyk 2006).

Papaya, originally from Central America, is growing well in both tropical and subtropical areas (van Wyk 2006). Still the production in most parts of Africa is just on a small-scale homegarden cultivation with two or three trees growing in a garden (Rice et al. 1987). Papaya contains lots of vitamins A and C and calcium, but also helps to digest proteins (van Wyk 2006). It is normally eaten a fresh but can also be preserved (Nagy and Shaw 1980).

Pineapple is originally from northern part of South America but has later spread to other parts of the world. It is growing especially in the dry tropics, often close by the sea (van Wyk 2006). Pineapple is eaten as a fresh fruit, but also to produce juice and canned products (Nagy and Shaw 1980). They are as well used to make chutneys and jams. The fruit does not contain so much energy, but it is a good source of vitamins A, C and E. Pineapple also contains protein-digesting enzymes which are helpful for swelling and inflammation (van Wyk 2006).

There are many citrus fruits growing in Africa, including lime (*Citrus aurantifolia* (Christm.) Swingle), lemon (*Citrus limon* (L.) Osbeck), orange (*Citrus sinensis* (L.) Osbeck), grapefruit (*Citrus paradisi* Macfad.) and mandarin (*Citrus reticulata* Blanco). Citrus fruits are cultivated in Zimbabwe, Mozambique, Swaziland, Zambia, Kenya, Ivory Coast and Madagaskar where they play an important role. Lime contains lots of vitamin C (van Wyk 2006) and it is normally used as a juice. Lemons are also used to make lemon juice (Rice et al. 1987). In the past, it has been used against scurvy in maritime shipping. Sweet oranges instead are the most important ones because it is possible to eat them fresh or pressed into juice. They are also nutritionally valuable because they contain lots of vitamin C, vitamin A and potassium. Mandarin is a valuable fruit as well because it contains more vitamin A than the other citrus fruits, but it as well contains vitamin C, calcium and potassium. People eat them freshly because they are easy to peel (Rice et al. 1987).

3.4 Indigenous fruit trees

The predominant natural forest type in southern Africa is called Miombo woodland. Miombo woodlands are dry forests in the tropical areas where annual precipitation is between 500-1500 mm and the dry season lasts from five to eight months. Miombo forests are the most extensive dry forest type in Africa. These forest types offer extensive ecosystem services and products. These, in turn, have a positive impact on local people's livelihood, food security, and adaptation and mitigation of climate change. However, as an important source of energy for the increasing population, Miombo forests are exposed to deforestation and, besides this, are threatened by both forest fires and uncontrolled, human-induced fires (Guedes et al. 2016).

In the Miombo woodlands there are many indigenous fruit trees (IFT), even 75 different types which produce eatable fruits (appendix 4). These fruits often provide for example good vitamins, minerals, fibers, proteins, sugar and oils which then offers livelihoods for the people in those areas (Akinnifesi 2004; Akinnefesi et al. 2006, Goenster et al. 2011). Therefore, these fruits are an important source of nutrition (Goenster et al. 2011), especially in famine and other emergency situations (Akinnifesi et al. 2006). Also, according to Luke

(2018) wild foods provide resilience and contributions to food and nutrition security, especially in those times when there is scarcity of staple food. Hence, IFTs play an important role in people's food security (Goenster et al. 2011), but as well in nutrition security (Kehlenbeck et al. 2013). Furthermore, these fruit species provide income (Goenster et al. 2011; Kehlenbeck et al. 2013) for the local people both in cities and rural areas (Moir et al. 2007).

One solution for meeting the food demand even more satisfactorily would be to domesticate some of these fruit tree species so people could grow them in their homegardens (Akinnifesi 2004). The need for this undoubtedly exists, as one can see from a study conducted in Malawi, Mosambik and Zambia in 2002, stating that 60 - 85% of the households were suffering a lack of food, 3 - 4 months a year. In this situation 26 - 50 % of the households resorted to indigenous fruits as a source of food (Akinnifesi et al. 2006). Also, according to study done in Kenya (Kehlenbeck et al. 2013) IFT species contribute to livelihoods in rural areas, especially during food shortages. In general, especially women and children benefit from IFTs (Goenster et al. 2011).

In southern Africa the population growth has already caused hunger crises due to a lack of food supply. The resulting need for an increasing food production causes the fields to suffer from overgrowth and decreased soil quality (Akinnifesi et al. 2004). Also, other external forces, such as droughts, are not uncommon anymore in the respective areas (Vähätalo et al. 2005), which ultimately decreases yields and enforces the challenge of a sufficient food supply (Akinnifesi et al. 2004). Above that, dry periods not only jeopardise plant based, but also animal based foods (Vähätalo et al. 2005).

In addition to this, also the pre-harvest time of staple crops might be time when there is food shortage. In this case some IFTs could provide fruits as emergency food for people (Kehlenbeck et al. 2013). Zambia and Malawi, used this same strategy of collecting fruits from nature during the famine in 2001 and 2002. This has already led to the point that fruits are difficult to obtain, and the situation does not seem to improve. That is why it is important to think about new strategies and technologies to produce more fruits in homegardens (Akinnifesi et al. 2004).

Despite the potential advantages, IFTs are not commonly cultivated and they are not commercialized even though they are widely growing in southern Africa. There is not enough information and knowledge about them yet, which restricts their cultivation (Ngadze et al. 2017). A study done in Kenya (Kehlenbeck et al. 2013) showed that IFTs were available, but people did not use them efficiently. Domesticating a few species would help to increase the number of IFTs planted on farms and in this way improve the nutrition and health of the people.

IFTs growing in Miombo forests have been under attempts of breeding for suitable cultivars, because by growing these species, local people could generate additional income and their nutrition could be improved. In order to breed the fruit tree species, the first step is to identify the species with help of the local people who know the species best. After this, the most suitable individuals of the respective species are chosen. These individuals are cultivated in orchards before they are handed over to local people for cultivation (Akinnifesi et al. 2004). Breeding fruit trees for cultivation is not new. For instance, Kiwi fruit which is originally from China, was bred for commercial cultivation in New Zealand at the beginning of 20th century (Akinnifesi et al. 2004).

Notwithstanding, a study by Akinnifesi et al. (2006) found that all people in Zimbabwe are using IFTs. Selling and eating these fruits clearly approved households' livelihoods and income. Also, according to Nyoka and Rukuni (2000) IFTs are getting more and more attention in Zimbabwe. Indigenous fruits are domesticated, then produced, collected, marketed and used in Zimbabwe. Locals, both poor urban people and communal farmers, have been widely using and selling these fruits to get additional income and nutrition to the daily diet of the family (Nyoka and Rukuni 2000). In critical times with these fruits people were able to live above the poverty line (Moir et al. 2007).

People are using different kinds of indigenous fruits. Mostly the fruits are used and sold as fresh ones (Nyoka and Rukuni 2000). Whilst many IFTs are an important source of nutritious food, the importance of these fruits is neglected (Moir et al. 2007). The use of these fruit species is still informal, they are not yet industrialized or commercialized. This is one reason why IFT production has not

yet increased so much among small holder farmers. Nevertheless, few IFT species have been processed already after their germplasm have been collected. These species are *Uapaca kirkiana*, *Strychnos cocculoides*, *Sclerocarya birrea* and *Parinari curatellifolia* (Nyoka and Rukuni 2000). Also, Benhura et al. (2013) have reported how in Zimbabwe, like in many other African countries as well, people are collecting and consuming IFTs. Especially when there is food shortage, people tend to eat indigenous fruits like *Parinari curatellifolia*.

Kehlenbeck et al. (2013) stated that when combining IFTs together with exotic species, it is theoretically possible to achieve a year-around production of fruits which helps home consumption and sales. According to their study it is helpful to have improved grafted species because grafted trees start to give fruits already after two or three years of planting, and people get better price from these products when they sell them. Especially women benefit from improved cultivation of fruits because they process the fruits. Still there is a lot potential in this to be improved.

3.5 Fruits as a part of people's livelihoods

3.5.1 Cash income

Worldwide it is said that homegardens can improve people's cash income in a positive way (Galhena et al. 2013), even though most of the produced products are used for the households' own consumption (Kumar and Nair 2004). If there are more fruits than the family needs for themselves, it is possible to sell them and generate income for the family (Pye-Smith 2008). Selling these products significantly improves household's financial situation. In this case, money is left to meet the basic needs like buying food and clothes. Besides this, homegardens bring surplus because the family produces products that would have to be bought otherwise (Linger 2014). According to High and Shackleton (2000) 28% of the products produced in homegardens in South Africa were sold whereas the remaining 72% were used in the household.

Some of the households might even grow fruits just to get income for the family. Furthermore, people can sell products that they anyway would grow for their family's needs or products that not so many others are growing and selling in the area. A beneficial aspect regarding the latter situation is the fact that there is hardly no competition with other sellers which facilitates the sale of those products (Linger 2014). It is also possible to bring extra value for the products by cutting or cleaning them before selling. In this way, households get more money when they sell the products afterwards (Akinnefesi et al. 2004).

A study conducted in Nhema area in Zimbabwe (Maroyi 2009) showed that it is important for the families to produce homegarden products. In this way they can satisfy their basic needs. Households get only small income by selling their homegarden products, but they might be a very important source of money especially for poor families. This reduces the poverty and can improve the quality of life. In Nhema area it was found out that people grew different kind of fruit trees like mangoes, guavas, limes, papayas, oranges, peaches and avocados around their homes in home fields.

A local fruit tree, known as masau (*Ziziphus* mauritiana), which is growing also in Zimbabwe, can be found commonly for sale in urban and rural markets. This fruit is often called "a poor man's fruit". People are selling these fruits in the local markets and it is therefore a good way to get income for those people who come from the areas where the fruit tree is growing (Nyanga et al. 2013). Masau originates from central Asia but was distributed to Africa (Kalinganire et al. 2012).

In developing countries women play an important role in food production (Landon-Lane 2011) including homegarden production. Even though it is not automatically women's role to take care of homegardens, they are often involved in it (Galhena et al. 2013; Kiptot et al. 2014). Women are often bringing new species to homegarden production and in this way, they are responsible about the species in their homegardens. Women also often take care of the actions in the homegarden (Kumar and Nair 2004). One way for women to earn money is to cultivate fruits and vegetables in their homegardens to sell them in the local markets. Women do not often have the possibility of going to work

because they are taking care of the kids at home. That is why selling homegarden products can offer an important independent way to earn money (Galhena et al. 2013; Kiptot et al. 2014).

It is also possible to get extra income by growing and selling fruit tree seedlings (Moir et al. 2007). According to Galhena et al. (2013), seedlings will also play an important role in the future to bring extra income for the families.

3.5.2 Nutrition

Fruits are beneficial for humans as they provide vitamins, fatty acids, sugars, proteins, energy, water, minerals and antioxidants (Akinnifesi 2004; Akinnefesi et al. 2006; Pye-Smith 2008). All these are mandatory for people's health (Pye-Smith 2008). The more diversified people's diet is, the better people's nutritional needs are met (Landon-Lane 2011).

As already stated above, women often take care of the family's children. That is why they have the opportunity of affecting children's nutrition. Homegardens are offering good and nutritious food for both the women and their kids. If women have knowledge in the fields of nutrition and cooking, it is possible to prevent anemia and vitamin deficiency (Galhena et al.; Kiptot et al. 2014). Further evidence of the importance of women on their children's nutrition can be found in studies of the FAO (2001). They have shown that when women are earning money, it has a higher positive impact on nutritional status and health of children than men's earnings do (FAO 2001).

In sub-Saharan Africa (SSA) 30% of the population suffer from malnutrition, mostly children and women (UNSCN 2010). Also, deficiency of vitamin A and iron is common mostly in whole SSA (Kehlenbeck et al. 2013). In many developing countries especially, children are having a lack of protein and vitamins. One reason for this is because they are not eating enough fruits and vegetables. For example, in Malawi people are eating less than 30g of fruits per day. World Health Organization recommends eating seven times more than this amount (Pye-Smith 2008). According to study done by Korkalo et al. (2015) deficiencies of micronutrients can cause health problems for adolescents in

SSA. In this age it would be important to get enough nutrition to avoid noncommunicable diseases and maternal mortality. Especially there were significant seasonal differences in the intake of vitamin A.

If households are adding more fruits and other homegarden products to their daily diet, they are less vulnerable to some diseases (Molina et al. 1993; Shankar et al. 1998). When eating fruits people get for example more vitamin A, iron and iodine to their diet (Molina et al. 1993). Vitamin C is important for absorbing iron (Kehlenbeck et al. 2013), but also vitamin A is a very important vitamin (Pye-Smith 2008).

It is considered that low intake of vitamin A is the third biggest health problem in Africa after AIDS and malaria (Kehlenbeck et al. 2013). In developing countries deficiency of vitamin A affects 75-140 million children in preschool age. This can increase sensitiveness to infections and therefore cause death (Ross and Harvey 2003). Every year, 600 000 children die to diseases in Africa which could have been prevented with sufficient vitamin A intake. A test result has shown that if improving the vitamin A levels of 6-59 months old children it can decrease mortality by 23% in those populations that are in a risk of deficiency of vitamin A (Ross and Harvey 2003).

There is also clear evidence that women suffering from vitamin A deficiency are more likely to transfer HI virus causing immune deficiency (AIDS) to their children through breastfeeding (Pye-Smith 2008). As well vitamin A deficiency has reported to cause eye lesions to 14 million people (Shah and Strong 1999). It is possible to avoid deficiency of vitamin A by eating for example mangoes, carrots and green vegetables (Landon-lane 2011). Also, breastfeeding is an important way to prevent vitamin A deficiency of children because of high levels of good factors, including retinol, in breast milk (Ross and Harvey 2003).

According to FAO (2001), studies done in the Pacific islands have shown that those people who have a homegarden are better nourished. In Solomon Islands, a study showed that people had a lower intake of vitamins A and C and iron if they did not have homegardens (FAO 2001).

According to Landon-Lane (2011) all the fruit trees are important sources of vitamins and minerals. When especially children are eating fruits, it is possible to decrease the number of daily meals because fruits are taking hungriness away (Linger 2014). By eating more fruits people could therefore improve their vitamin intake (Akinnifesi et al. 2004). For example, already two guava trees growing in the homegarden can offer enough vitamin C for the family with six people (Pye-Smith 2008).

A good example of the IFT species is masau, *Ziziphus mauritiana*. In Zimbabwe many people are consuming this fruit and it affects people's diet in a positive way. Especially children and adolescents benefit from masau as it brings proteins, carbohydrates and micronutrients to their daily diet. Based on the study result, masau's nutritional value in the right amount is even higher than some more common fruits like orange or mango. In the areas where the fruit tree grows, this fruit should be consumed more widely since it positively contributes to the daily diet and its price is low (Nyanga et al. 2013).

3.6 Food security and nutrition security

"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996). The food security definition consists of four dimensions which are food availability, food access, utilization and stability (FAO 2006).

A more fundamental term for food security is nutrition security. It is fulfilled when a person is guaranteed adequate nutrition, safety and care. Balanced and healthy nutrition satisfies the individual's energy needs and contains enough and balanced proportions of proteins, vitamins, minerals, essential fatty acids and trace elements. Sufficient water and wastewater services, hygiene and health services are also needed to ensure nutrition security (Karttunen et al. 2014).

A good health is the base that a person can live an active life, satisfy his/her basic needs and take part in community actions. Nutrition is one of the most

important aspect which affects the health and wellbeing of a person. Nutrition and versatility should be always taken into consideration when talking about sustainability of food systems (Karttunen et al. 2014).

Micronutrient deficiencies and food insecurity are causing diseases and mortality world-wide, but especially in developing countries (FAO et al. 2013). It is important to get lots of energy from food, but this one does not guarantee that a person has got all the important nutrients (Karttunen et al. 2014). Often people's diet does not consist enough of vitamins and micro nutrients. This phenomenon is called hidden hunger (Akinnefesi et al. 2004), of which suffer about two billion people. Both hidden hunger and malnutrition can affect in a negative way to human's development, especially children's. These can weaken social, intellectual and physical development and even lead to death. Often hidden hunger and malnutrition are passed from generation to generation and continue through life (Karttunen et al. 2014).

Nutrition work is a good way to improve nutrition security, high investments are not automatically needed. For example, with small chores it could be possible to prevent the death of a million children annually. Also, taking care especially of infant's and children's nutrition can cause a 2-3% growth in state GDP. Nutrition can be improved locally by several means. Communities and schools have an important role to play in that. With training programs, teaching gardens and other programs aiming behavioral changes, it is possible to increase the number of plants consisting lots of vitamin A in production and household consumption. Especially traditional food plants can play a major role in local food security. Therefore, there is also a clear connection between preservation of biodiversity and food security (Karttunen et al. 2014).

The Director-General of FAO has stated that urban and peri-urban agriculture is very important for the urban population's food security. UPA increases access to food and as well food availability year around. Poverty in cities should be reduced and in this way guarantee food security for all the people (FAO 2001).

According to Mbow (2013) trees have a positive impact to food security and climate change since having trees in landscape can ease those challenges.

Trees have deep and extensive rooting systems which make them to be less sensitive for droughts when comparing to staple crops. Even if the staple crops fail, fruit trees still give a harvest. That is why fruit trees are contributing both to food and nutrition security (Kehlenbeck et al. 2013). Supporting homegardens can be a way to strengthen food security (FAO 2001). Also, according to Kabunga et al. (2014) producing fruits, but also vegetables, can be beneficial for food security and affect especially to women's, who are in childbearing age, anemia levels. IFTs can also affect in positive way to nutrition security. *Strychnos* spp. can for instance improve nutrition security in the local areas especially if paying more attention to their processing (Ngadze et al. 2017).

Studies conducted in Africa, Asia and Latin America found positive effects of homegardens regarding the prevention of malnutrition and food insecurity. According to these studies, homegardens also offer further benefits, including livelihood opportunities and income, in particular for families who are resource-poor (Galhena et al. 2013).

4 MATERIALS AND METHODS

4.1 Study area

The capital of Zimbabwe is Harare which is located in the North East part of the country. There are around 1.5 million people living there of whom 32.2% are living in urban areas (CIA 2018). The official language is English, but people also speak widely two local languages called Shona and Ndebele. The city is located 1500-2000 m above sea level (Mbiba 1999). The capital receives an average of 725-974 mm of rainfall per year and the mean temperature is 15.5-20 °C (FAO 2012). The vegetation type in the area is mostly tropical dry forest (FAO 2001). Rainy season starts in November and lasts until March (Mamombe et al. 2016) which means most of the rainfall comes during the summer months (Maroyi 2011).

Zimbabwe's economy depends on agriculture and mining sectors. From 1998-2008 there was a contraction in the economy which ended up with hyperinflation. After this, economy grew again from 2010-2013, but fell once more in the years from 2014-2017. This was because of decreased investment, low revenue of diamonds and poor harvests (CIA 2018).

The study was conducted from September to November 2015 in Dzivarasekwa district (appendix 1), which is located in Harare. Dzivarasekwa is also known as Dzivaresekwa. It is a peri-urban district which is located 16 km west from the city center of Harare. Dzivarasekwa is a very poor area with approximately 156 000 inhabitants. The population density in the area is very high. The area contains 7 different areas: Dzivarasekwa 1-4, Dzivarasekwa Extension, Kuwadzana phase 3 and Tynwald South. Vegetation in Dzivarasekwa is wooded grassland or agricultural land (Forestry Comission of Zimbabwe 1996).

Every household in Dzivarasekwa area has at least some kind of homegarden. The size of them varies, but in general they are quite small. It is typical that people grow at least one fruit tree species in their garden together with vegetables. Unlike in many other tropical or subtropical homegardens, in

Dzivarasekwa area people do not keep any livestock in their homegardens. Due to this also forage does not play a pivotal role in the area.

The study was conducted together with the Zimbabwe Aids Orphans which is a Finnish aid organization. Their aim is to help poor, but talented orphan school kids in Dzivarasekwa to provide them an opportunity to go to school and in this way to provide better future prospects for them. The society has also a forest project in the area where they have rent 60 hectares land from the city of Harare. The purpose is to provide firewood for the local community, growing fruits and vegetables, support children's environmental education and help local people to get bigger crop yields. The society teaches local people about agroforestry system and help them to cultivate fast growing tree species together with other local trees. The project has also a small orchard where they are growing at least mangoes and lemons. There is also a tree nursery where they are able to grow more than 60 000 eucalyptus seedlings every year. In the future they are planning to extend the vegetable garden from 0.12 to 0.53 hectares. Also, the plan is to keep 200 rabbits and 200 broilers in the forestry project area to diversify the diet for the children (Zimbabwe Aids Orphans 2018).

4.2 Questionnaire

The case study material was collected by interviewing people who live in Dzivarasekwa area. The interviews were semi-structured questionnaires (appendix 2) which left space for new questions during the interview. Questions were chosen so that they supported the aims of the study. Some questions were added to the rest of the interviews in the middle of the interview process as the interviewer noticed some important things were not part on the questionnaire yet. The aim of the questionnaire was to get an image about the fruit trees grown in the homegardens and draw conclusions out of it.

4.3 Data collection

The case study included interviews of local Dzivarasekwa people who have homegardens. All the interviewees were chosen according to some prerequirements listed below. Interviews were conducted in English or in the local language Shona. In the latter case, an interpreter was translating from Shona to English language. The interviews took place between 29 September to 1 November 2015.

In total 37 interviews were conducted from which three were test interviews. In total 34 interviews were then analysed. The interviews covered all the seven different areas in Dzivarasekwa (table 2) to get a rich picture about the situation. The first interview was done randomly in Dzivarasekwa I. The interviewed households were chosen based on fruit tree availability in the garden, people's presence in the garden at that time and people's acceptance of the interview.

Table 2. Conducted interviews by study area

Area	Number of interviews
Dzivarasekwa 1	5
Dzivarasekwa 2	7
Dzivarasekwa 3	7
Dzivarasekwa 4	5
Dzivarasekwa extension	3
Kuwadzana phase 3	4
Tynwald South	3
Total	34

Ultimately, only the households with one or more fruit trees were chosen, whereby it was taken care of that households from all of the seven areas in Dzivarasekwa were represented in the study in order to obtain a good understanding of the whole Dzivarasekwa area. The house location was recorded with a GPS device – Magellan Navigation triton 400 (global position system) – and the coordinates were noted. None of the interviews were recorded because there was no recorder available and it might have aroused suspicion among the local people. Also measuring the exact size of the homegardens was not possible due to the same reasons.

From the interviewed people with homegardens five cases were still randomly chosen. From those homegardens sketches of the homegardens both from above and of the projection were drawn to see how the fruit trees are located in the garden and how their canopy layer looks like.

4.4 Analyzing data

Information collected from the households included the size of the households which covered the total number of people in the family and separately different genders and children. The size of the homagardens were measured roughly by walking it and counting the steps. Homegardens' were divided into three different size categories: small (50-100 m^2), middle size (101-150 m^2) and large (150 m^2 <).

Also, facts about owned or rent land in some other areas like in Dzikwa project area was asked as well as how people have invested to their homegarden. Major uses of the fruit trees (eating, selling, medical, forage), number and species of the fruit trees were collected. Information about where the seedlings or seeds were from and when the trees start fruiting season were asked as well. Information about interest towards other fruit tree species and growing them were collected as well as facts about interest towards indigenous fruit tree species.

A new question was added to the interview form at the time when there were still 23 interviews to be conducted. The question asked was why people do not have more fruits growing in their homegarden, at that time. It was also asked, if people would be interested in trying new species. Questions were also asked about the purchase of fruits; if people buy fruits, which fruits they buy and from where. In 26 interviews (question was added during the interview process) it was also asked if the price ever affects the decision to buy fruit trees. Information was collected about the eating habits of fruits in the household: who eats fruits and how often. Besides fruit tree species, also crop, tree and other species' appearance were asked in the interviews to get an overview what people are growing in their homegardens.

These data were collected in Excel. Analyses were done by using SPSS Statistics 25 program. Chi-square tests were used for contingency tables and ANOVA analysis of variance tests used for continuous numeral dependent variables. Chi-square test was used to check whether the number of different fruit tree species depends on gender. With ANOVA analysis of variance test it was checked whether the total number of fruit trees in the homegarden depends on area size of the garden. With the same test it was also checked if the amount of different kind of fruit tree species depend on area size of the homegarden.

Three different kind of statistical analyses were done to check if selling the fruits is depended on certain factors. Chi-square test was used to check whether the area size of a homegarden and selling the fruits were positively connected. ANOVA test was used to analyse if selling the fruits depends on the total number of fruits in the garden. Chi-square test was as well used when it was analysed whether the number of family members in the household affects people's willingness to sell fruits. Furthermore, with the same test it was investigated whether the use of fruit trees in medical purposes depends on the size of the homegarden.

5 RESULTS

5.1 Size of the households and homegardens

In the family size all the household members, children, women and men, are counted together. In this part the problem was that in four interviews result for the question family size was different than total number of children, men and women counted together when these were asked separately. At this point the results were changed that later option was considered right. The number of people in the families varied between 2 and 16 members (figure 1). The average size of the families was 6.0.

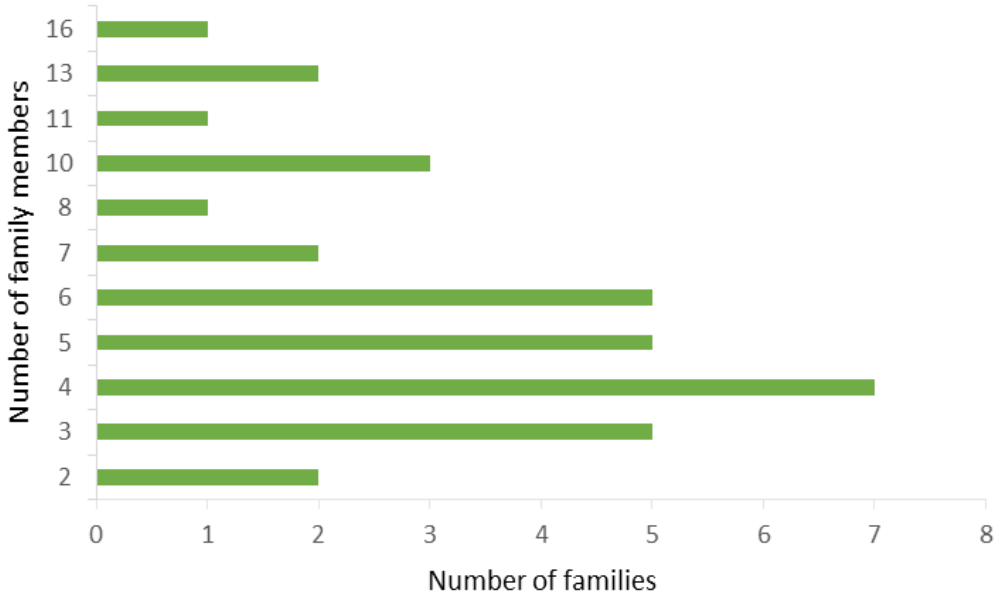


Figure 1. The size of the families

In the families there were 0 to 7 children per interviewed household. The average was 2.5 children per household, but 7 households did not have children. Also 7 households did not include men in the family, but on the average there were 1.6 men per household. Number of women per household was 1.9. Only in one household there were no women living there.

The number of different fruit species in the homegarden did not depend on gender (p=0.949) (figure 2).

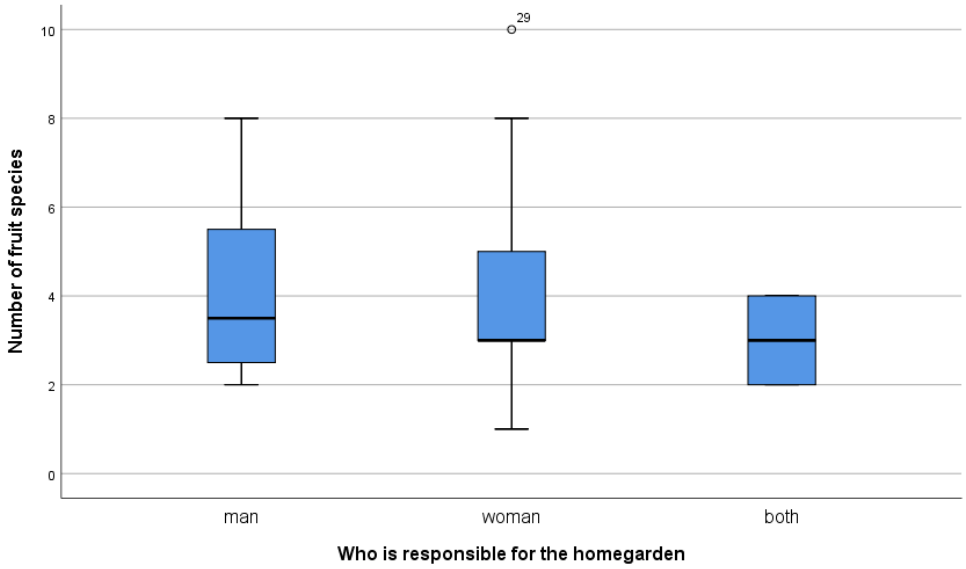


Figure 2. Number of fruit tree species in the homegarden against gender of the responsible person.

From all the interviewed households 26 were owning the house where they were living and 8 households did not own it. From the ones who owned the house, 13 households were also renting rooms for other people. In total there were 15 small, 10 middle sized and 8 large homegardens. From one homegarden there was no info about the size.

Figure 3. The streets of Dzivarasekwa and vegetables growing in the right side. (Photo: Haavisto-Meier 2015)

In some of the streets, people were also growing vegetables next to the road (figure 3). No household had yet land in the Dzikwa project area, but one household was supposed to get land there. Instead 19 households (55.9%) had land somewhere else. It was not asked where the land is located and what people are growing there or how they use the harvest.

5.2. Fruit trees grown

5.2.1 Number of fruit trees

Every household which was interviewed had at least one fruit tree growing. The most common number of fruit trees that people were growing in their homegardens was 2 and 3, covering 47% of the households (figure 4). Still on average people had 4.4 fruit trees growing in their homegardens. In small homegardens people had on average 3.7, in medium size homegardens 3.9 and in large homehardens 6.4 fruit species growing.

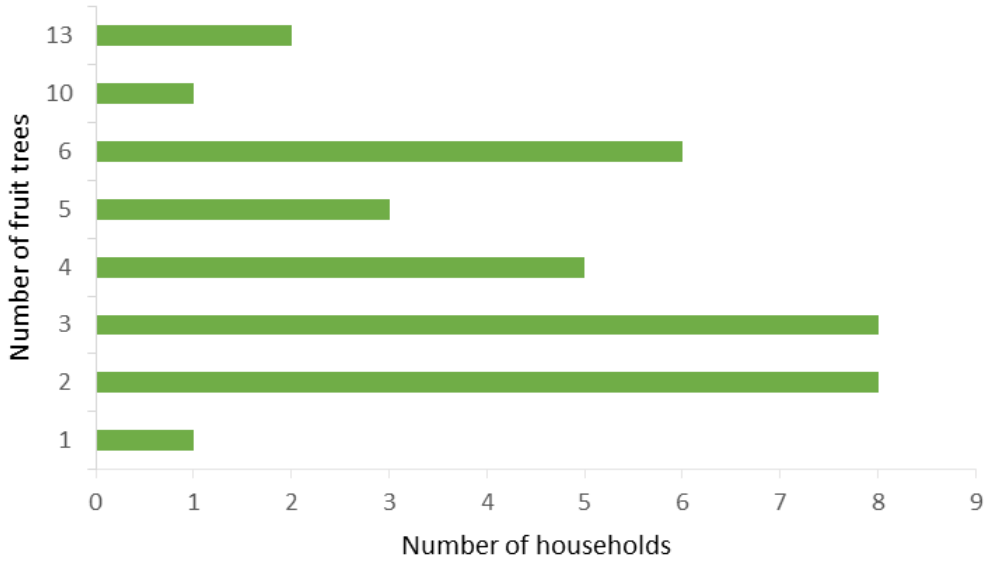


Figure 4. The number of fruit trees per household.

Fruit trees that were grown in the interviewed homegardens were 1-35 years old. People did not always know the exact age of their trees and they just estimated a vague timeline.

The total number of all the fruit trees grown did not depend on the area size of the homegarden (p=0.083) (figure 5).

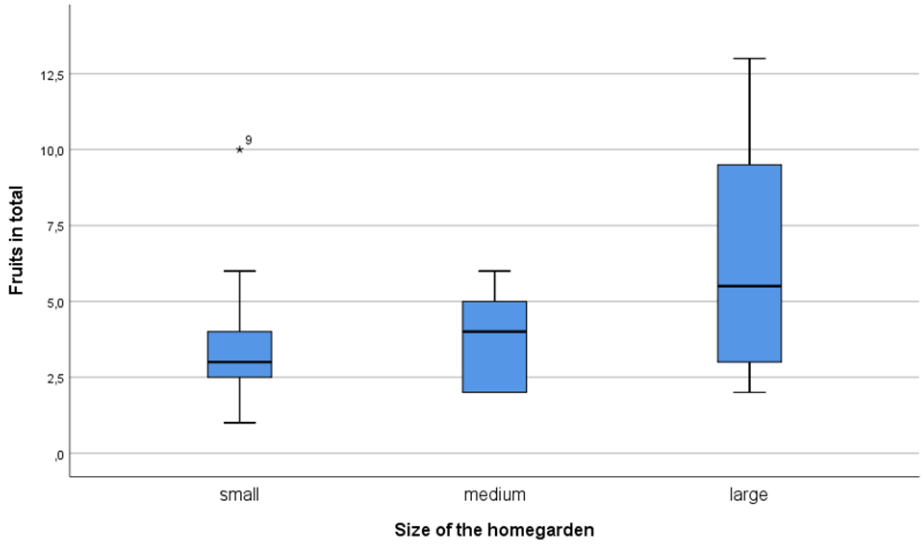


Figure 5. Area size of the homegarden and number of fruit trees in total.

5.2.2 Fruit tree species

In total 16 different kinds of fruit tree species were found from the interviewed homegardens (figure 6). The most common species were mango (*Mangifera indica* L.), avocado (*Persea americana* Mill.), guava (*Psidium guajava* L.), peach (*Prunus persica* L. Batsch), lemon (*Citrus limon* (L.) Osbeck) and banana (*Musa sapientum* L.). People had on average 3.9 different fruit tree species growing in their homegardens. In total 29 homegardens (85.3%) out of 34 had mangoes growing which made it the most popular fruit tree. In six of those 29 homegardens there were more than one mango tree growing.

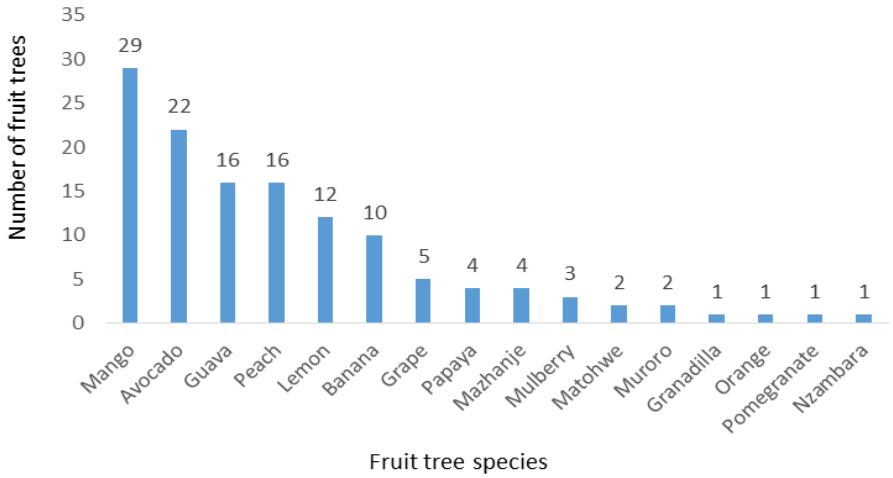


Figure 6. Rank abundance of fruit trees in the homegardens.

Furthermore, four different kinds of IFT species were found. These were mazhanje (*Uapaca kirkiana* Müll.Arg.), matohwe *(Azanza garckeana* (F.Hoffm.) Exell. Hillc.), muroro (*Annona senegalensis* Pers.) and nzambara (*Carissa edulis* Vahl.).

Both banana (figure 7) and papaya (*Carica papaya* L.) (figure 8) are trees which can provide fruits around the year. (Note of the author: Technically, banana is a herb, not a tree, but it is covered by the present study.) In the interviewed households in total 12 households were growing these fruit trees in their homegardens (figure 9). This is in total 35.3% of all the interviewed households.

Figure 7. Banana (*Musa sapientum*) growing in the research area (Photo: Haavisto-Meier 2015)

Figure 8. Papaya (*Carica papaya*) growing in Dzivarasekwa (Photo: Haavisto-Meier 2015)

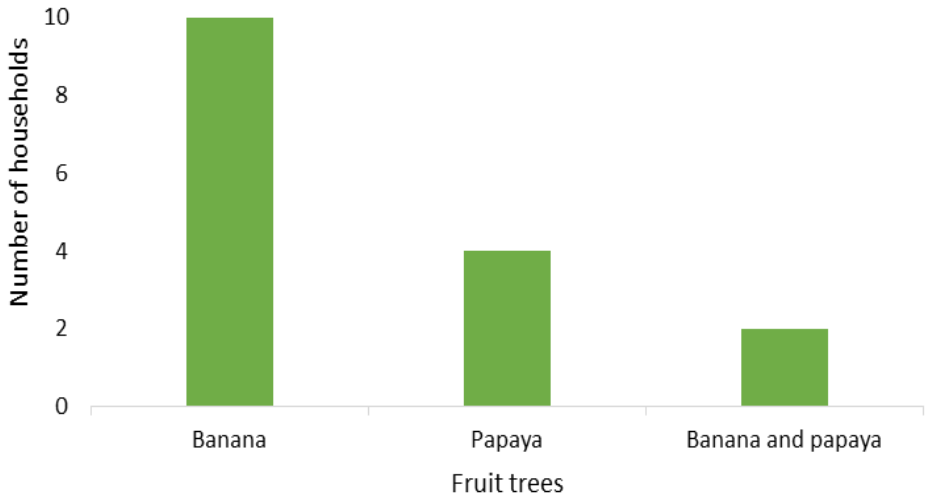


Figure 9. Number of households who are producing banana or papaya or both of them in the homegardens

The number of different tree species did not depend on the area size of the garden (p=0.415).

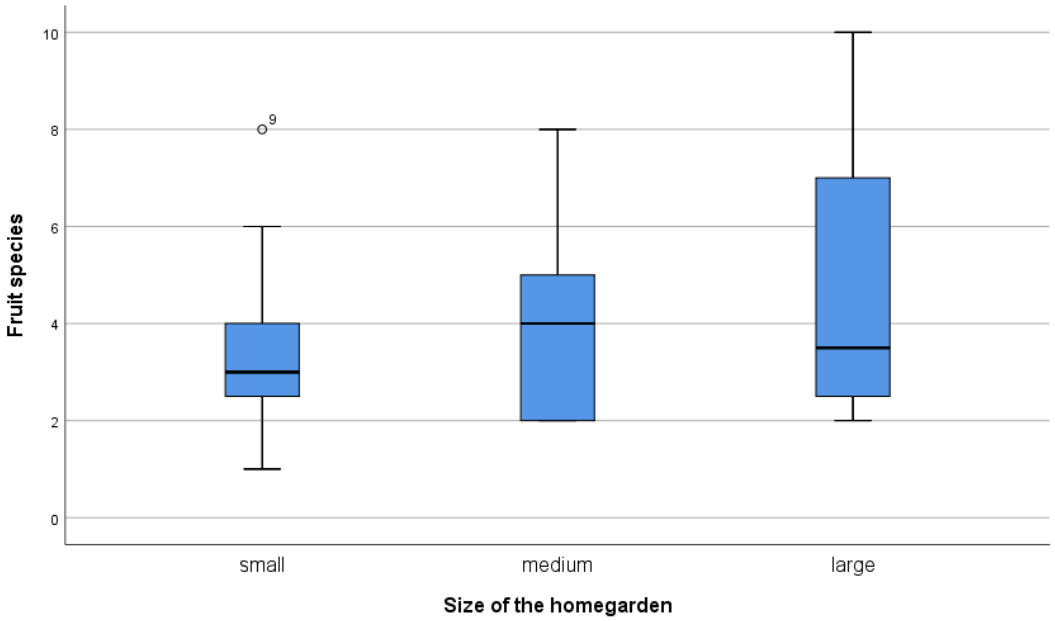


Figure 10. The size of homegardens from small to large and number of different fruit tree species.

People did not know exactly what varieties their fruit tree species were or if they were improved, for example grafted. Some people told their mangoes were small, big, long or sweet ones and some told they had either red or white guavas. Also, avocados were mentioned to be big, brown or green ones.

However, 33 households (97.1%) answered that they would be interested in having improved varieties from those species they know, if they would be available.

From the interviewed households 50% said they have not tried to grow other species before, but 47.1% told they have tried other ones too, one answer was missing. These species were apples (*Malus domestica* Borkh.), avocados, bananas, grapes (*Vitis vinifera* L.), guavas, lemons, mangoes, mulberries (*Morus* L.), mazhanjes, oranges (*Citrus sinensis* (L.) Osbeck), papayas and peaches.

5.2.3 Indigenous fruit trees

Almost every household used naturally growing fruits which were from IFTs. They got them from their rural homes, from forest or from markets. Matohwe (*Azanza garckeana* (F.Hoffm.) Exell & Hillc.), mazhanje (*Uapaca kirkiana* Müll.Arg.), tsubvu (*Vitex mombassae* Vatke), masau (*Ziziphus mauritiana* Lam.), baobab (Adansonia digitatae L.), nyii (*Berchemia discolor* (Klotzsch) Hemsl.), nhunguru (*Flacourtia indica* (Burm. f.) Merr), svazva (*Prunus domestica* L.), matufu (*Vangueriopsis lanciflora* (Hiern) Robyns), mhute (*Syzygium cordatum* (Hochst.)) and matamba (*Strychnos spinosa* Lam.) were mentioned in the interviews. 25 interviewees said they would like to grow indigenous fruit trees in the homegarden or in some other cultivation area. From these 25 one said that she/he would like to grow them in the Dzikwa land, one would be interest to grow them in the forest and one somewhere else. 5 interviewees told they would not like to grow them and 4 were not sure.

Matohwe (figure 11) seemed to be the most common one that people would like to grow and use. However, four interviewed households even produced mazhanje, two households grew matohwe, one household maroro and one zambara in the homegardens.

Figure 11. Matohwe (*Azanza garckeana*) growing in the left side. (Photo: Haavisto-Meier 2015)

5.2.4 Seeds and seedlings

Interviewed people got their fruit tree seeds and seedlings from many different places (table 3). In the same household people might have got their seeds or seedlings from couple of different places. However most common was that people got the seeds directly from the fruits itself. Also, supermarkets and markets were common place to get them. The answer “other place” included different following answers: field, work, other town, plot or they came on their own.

Table 3. The origin of the fruit tree seeds and seedlings.

Origin	Households
Fruits	11
Supermarket/market	7
Nursery	2
Other people	3
Already there	2
No idea	7
Other place	5

5.2.5 Fruit yield

Interviewed people could not tell how many fruits they get from their fruit trees. Instead 30 (88.2%) interviewed households answered that the harvest they get from their fruit trees is enough for the family's daily need.

From the last 11 interviews it was also asked how the people would use the harvest if they grew more fruit trees. From these households 7 said they would sell the fruits they would get, 3 said they would eat them and 1 household said they would use them both for food and for selling.

5.2.6 Future aspects

In total 33 households (97.1%) out of 34 would be ready to try new species or improved varieties from the species they know if there would be seedlings available. People would be ready to grow the following fruit tree species if there would be seedlings and enough space in the homegarden: Apple, apricot (*Prunus armeniaca* L.), avocado, banana, granadilla (*Passiflora ligularis* A.Juss.), grape, guava, mhute (*Syzygium cordatum* (Hochst.)), lemon, lychee (*Litchi chinensis* Sonn.), mango, mulberry, masau, mazhanje, orange, papaya, peach, pear (*Pyrus communis* L.), pineapple (*Ananas comosus* (L.) Merr.), pomegranate (*Punica granatum* L.) and plum (*Prunus domestica* L.) However not all these species can be grown in Dzivarasekwa due to climate reasons.

In total 85.3% of the households were planning to get new fruit trees when the existing ones will die. From the households 2 answered they are not planning to get new ones and 3 households left empty answer.

5.2.7 Limiting factors

From the households 19 out of 23 (82.6%) answered the reason for not having more fruit trees is limited space. One of these households told the city does not allow them to have more fruit trees growing. From the interviewees 2 told there are no seedlings (figure 12) available and that is a reason why they do not have more fruit trees, 1 household said soil is not suitable, 1 household told roots can

break a house and 2 households told how they have tried, but the fruit trees died. One of these households told that both space and seedling were the problem.

Figure 12. Mango (*Mangifera indica*) seedling growing in the orchard. (Photo: Haavisto-Meier 2015)

5.3 Other species and investment to homegarden products

In total 21 households were also growing crop species in their homegardens, which is 61.8% of the interviewed households. People were growing following species: beans, chinese vegetables, covo (*Brassica oleracea* L.), maize (*Zea mays L.*), bononGwe (*Amaranthus hybridus L.*), onion (*Allium cepa L.*), okra (*Abelmoschus esculentus (L.) Moench*), pumpkin (*Cucurbita pepo*), spinach, spring onion (*Allium fistulosum L.*), sugar cane (*Saccharum officinarum L.*), sweet potato (*Ipomoea batatas (L.) Lam.*) and tomato (*Solanum lycopersicum L.*). The most common one was covo which was grown in 17 homegardens. Other popular ones were onion which was grown in 8 homegardens, maize which was grown in 5 homegardens and sugar cane which was found in 5 homegardens as well.

In 7 homegardens were other tree species than fruit trees growing which was 20.6% of all the interviewed homegardens. 21 households were growing still

some other species which included flowers, bushes, green flowers, seedlings, herbs and a cactus. This covered 61.8% of all the interviewed households.

It varied between households who was responsible of the homegarden. Most common answer was women, but the difference to men was not that significant. In three interviews it was not find out who was the responsible person.

Table 4. Persons responsible about the homegardens

Person responsible	Households	%
Woman	17	50,0
Man	12	35.3
Man and woman	2	5.9
No information	3	8.8

A total of 28 households (82.4%) were watering the different plant species in their homegardens. From the households 16 (47.1%) were fertilising, 1 household (2.9 %) spraying, 4 households (11.8%) doing some kind of soil cultivation and 3 households (8.8%) were pruning the plants.

5.4 Fruits as part of livelihood

Three different uses of fruits grown in the homegardens were identified (figure 13): home consumption, selling, other.

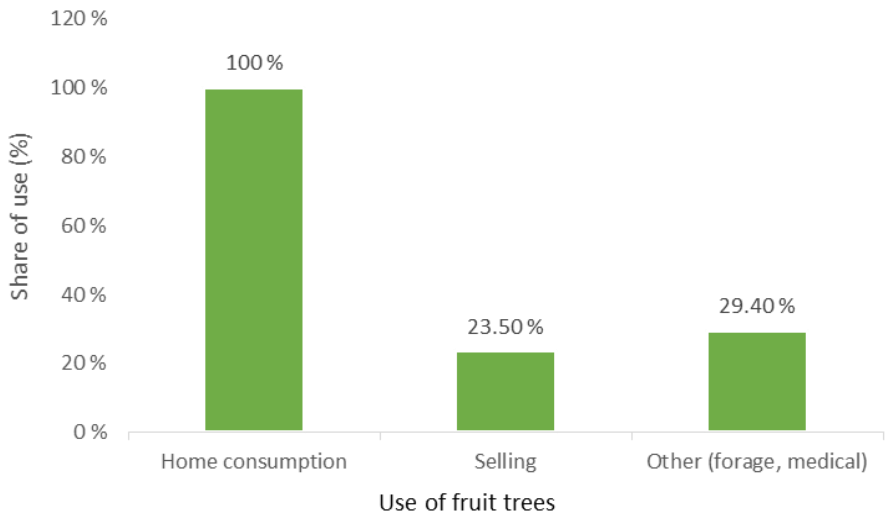


Figure 13. Use of fruit trees, three different ways how people used the fruit trees growing in their garden.

5.4.1 Part of nutrition

All the interviewed households were using the fruits they produced for home consumption (figure 13). In all the households all the family members were eating fruits. Fruits were part of the daily or weekly nutrition in the households. In two household's kids were the ones who were eating more fruits than other family members, but still in every household all the family members were eating them.

When it was asked what people are eating daily and what meals do they have, 12 households mentioned fruits as part of their daily diet. From these 12 interviewees 4 told they were eating fruits twice a day. Typically, most of the people had 3 meals a day: breakfast, lunch and dinner. Some households had 4 meals per day, then they had also midmorning meal which was normally tea and bread. Breakfast was either maize porridge or bread with margarine, avocados, eggs or peanut butter and tea. Lunch varied the most between households, but often it was sadza (maize porridge) or rice with vegetables or soup and sometimes meat if there was money for it. Some people had only juice for lunch. Dinner was typically sadza with vegetables and meat or fish. Few households ate also fruits, beans or milk.

In total 33 households out of 34 were buying fruits for home consumption from Mbare (suburb of Harare where is the major fruit and vegetable market of Zimbabwe), local markets, supermarkets, markets or town. Most common fruits were apple, banana and orange. Guava, lychee, masau, mazhanje, nyii, baobab, avocado, mango, peach, lemon, pear and plum were also mentioned. Price affected 69% of the interviewees' purchase decision.

5.4.2 Part of income

From all the households only eight produced so much fruits that they could sell them in the local markets (figure 13). Many households would have liked to sell products if they had grown more fruits. According to the interviewees the strongest limiting factor in the cultivation of fruit trees was the small size of the

homegarden. This restricted sales because households were large and consumed most of their yield themselves instead of selling the fruits.

Selling fruits and area size of the garden were not connected (p=0.155). Selling the fruits was also not dependent on the total number of fruit trees in the garden (p=0.278). Selling fruits did not depend on the number of family members in the household (p=0.374). All these three results mean that neither the size of the homegarden, nor the number of the fruits in total in the garden or number of people in the household affect people's decision to sell fruits.

5.4.3 Part of other usage

Ten households used the fruit trees for other purposes than home consumption or selling (figure 13). All these ten households used the trees for medical purposes. For example, households used guava leaves against flu by boiling them in the water and drinking it. Fruit trees were also often mentioned to give shade in the garden. During the hot and sunny day people were sitting under the fruit trees to feel more comfortable to stay outside. Also, oxygen, manure, tree planting and fuel were mentioned as a reason to grow fruit trees. This shows that fruit trees can benefit households in many different ways.

The use of fruit trees in medical purposes did not depend on the size of the homegarden (p=0.260).

5.5 Descriptive maps of homegardens

The first homegarden of which a descriptive map was drawn was interview number 14 (figure 14). In this homegarden there were two different fruit trees: mango and matohwe. Both fruit trees were located in the front yard. The size of the garden was small and the scale in steps can be seen in the figure (14). While the interview took place, some household members were sitting under the mango tree to be in the shade. In figure 15 it is possible to see the canopy profile of the fruit trees.

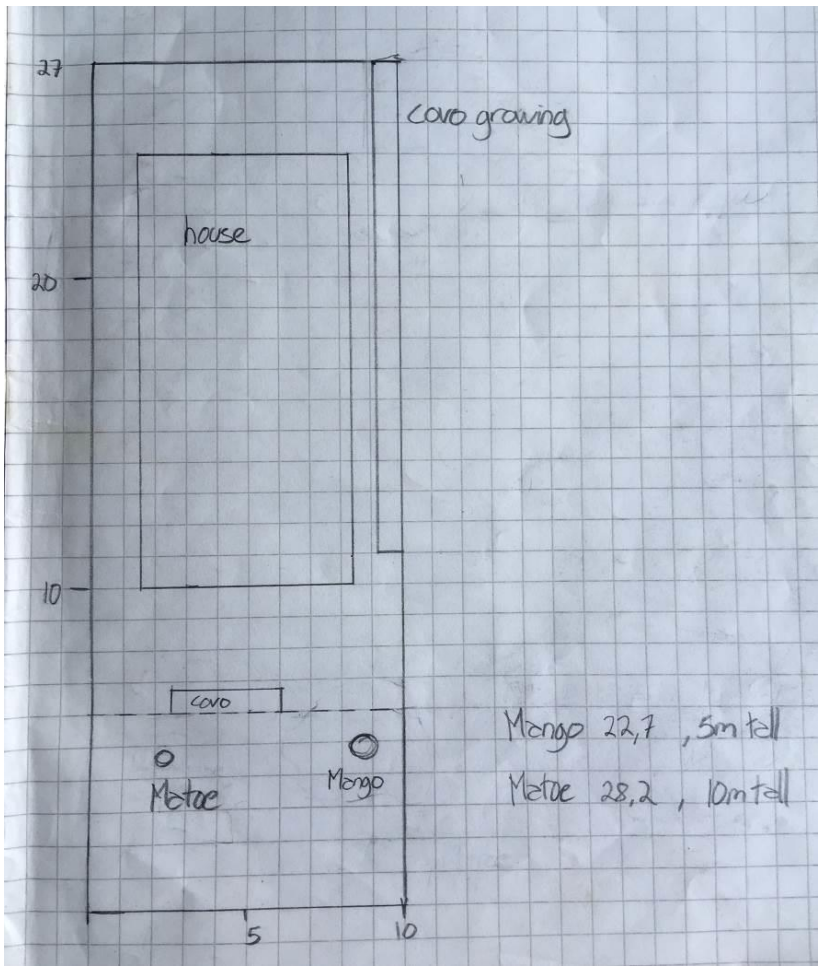


Figure 14. Location of the fruit trees from the interview number 14.

Figure 15. Canopy profile from the interview number 14.

In the second descriptive map, interview number 17 (figure 16), they had in total eight different fruit tree species growing: avocado, grape, guava, lemon, mango, matohwe, orange and peach. In the homegarden there were in total 9 fruit trees and grape growing around the fence. Fruit trees were grown in the front yard, except avocado which was growing outside of the fence around the home. Many of these trees were growing either in the left or right side of the front yard (figure 17). The size of this homegarden was small.

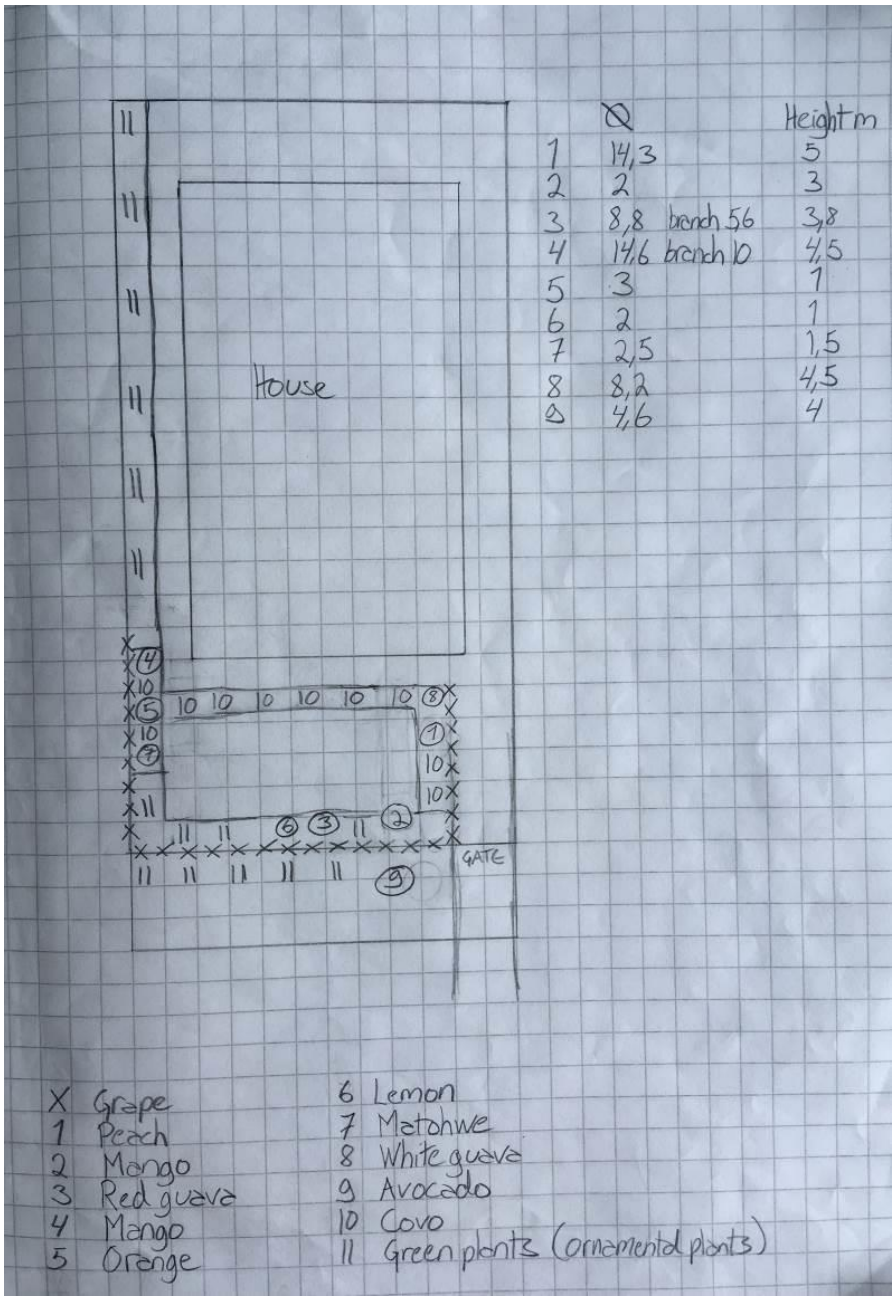


Figure 16. Location of the fruit trees from the interview number 17.

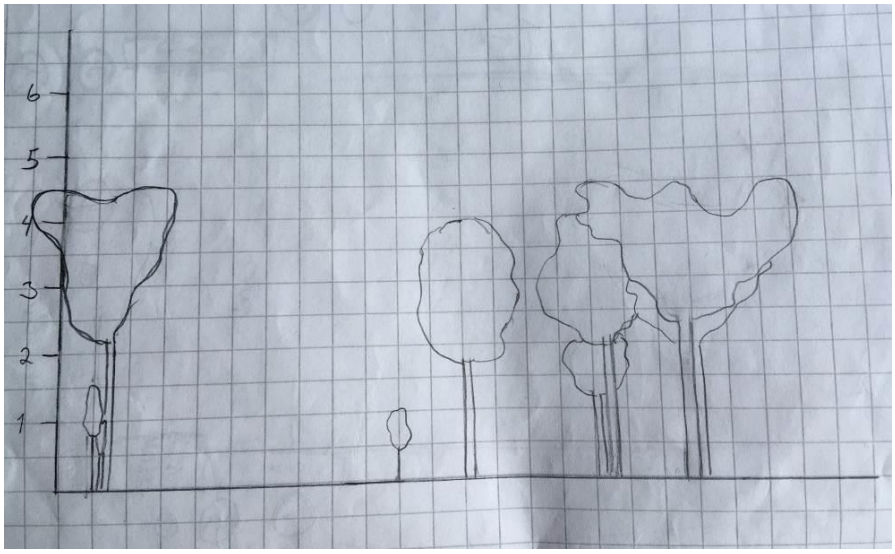


Figure 17. Canopy profile from the interview number 17.

In the interview number 25 (figure 18) the descriptive map shows that in the homegarden there were in total eight different fruit tree species growing: avocado, banana, guava, lemon, mango, maroro, papaya and peach. In the homegarden there were in total 13 fruit trees and also covo and maize. Fruit trees were grown both in the front and back yard and they used different canopy layers (figure 19). The garden was big and was diverse in its species.

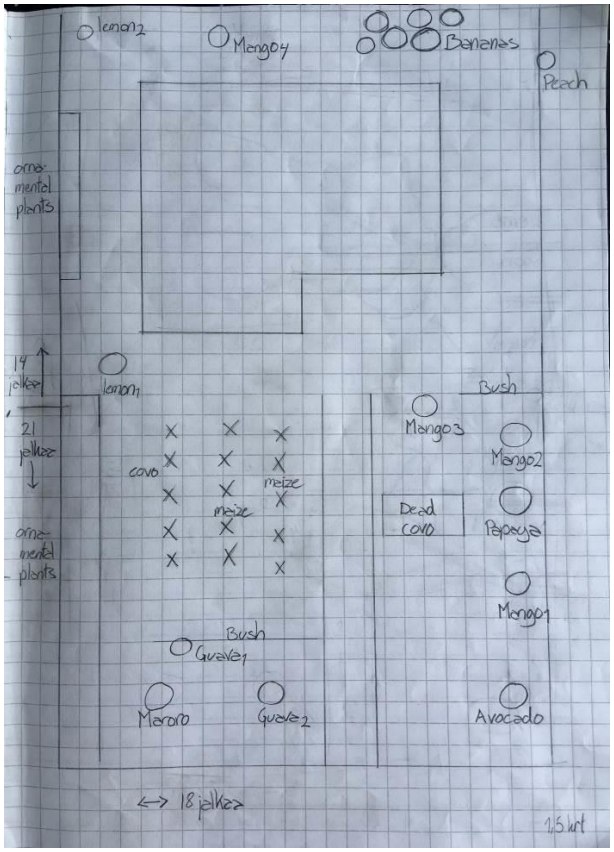


Figure 18. Location of the fruit trees from the interview number 25.

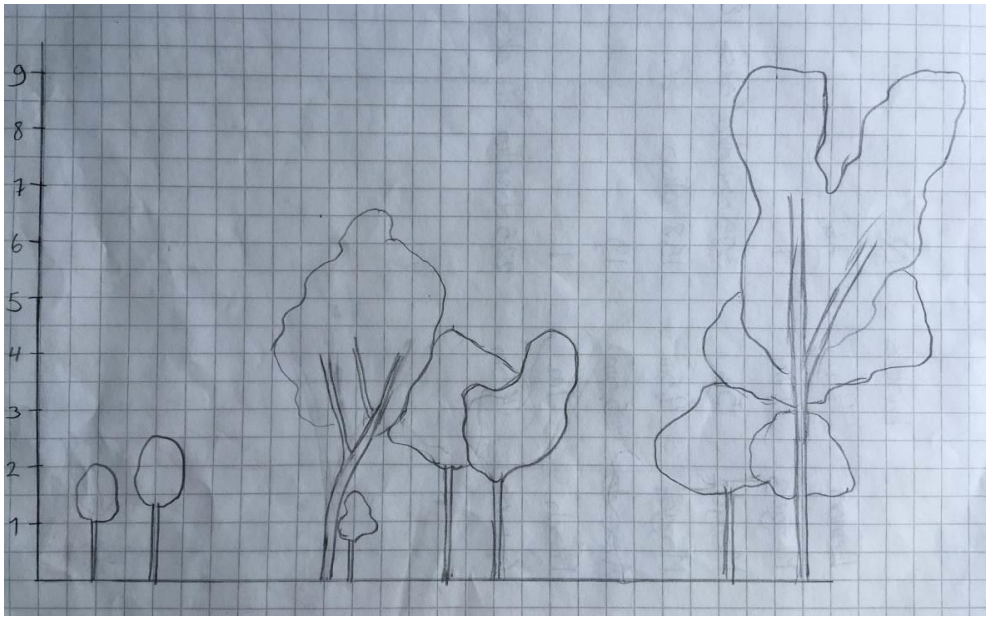


Figure 19. Canopy profile from the interview number 25.

Fourth homegarden where the descriptive map was drawn was interview number 29 (figure 20). This homegarden was middle sized and in the garden there were in total six different fruit species growing: avocado, grape, guava, lemon, mango and peach. Grape was growing on the fence of the homegarden. In the homegarden were in total eight fruit species and vegetables including covo, maize, onion and spinach. Fruit species were grown in the front and side yard, vegetables in the front yard only.

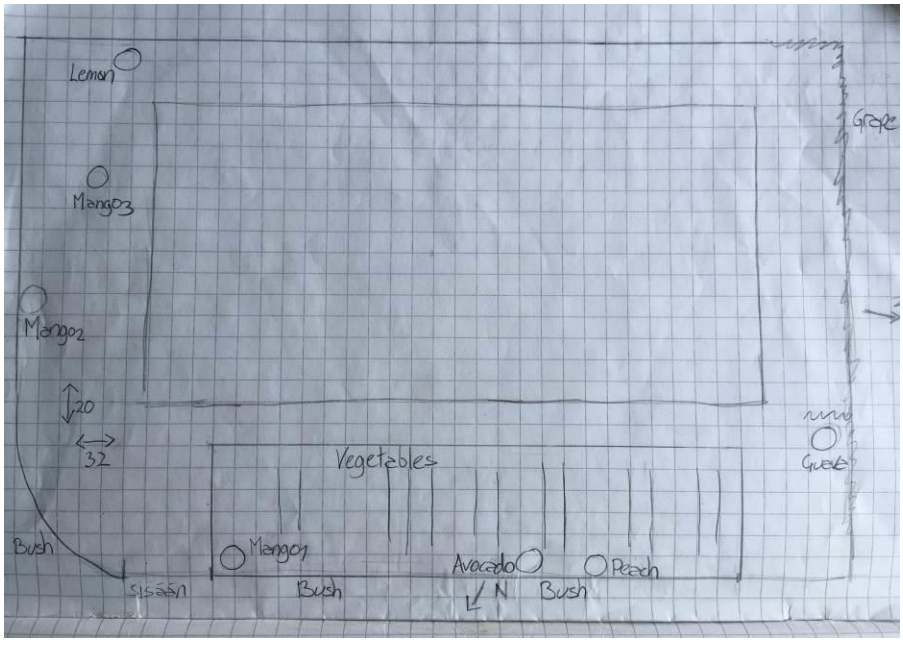


Figure 20. Location of the fruit trees from the interview number 29.

In the homegarden of the interviewed household number 34 (figure 21), there were growing four different fruit tree species: avocado, guava, mango and peach. The garden was a big one and in the figure (21) can be seen the size by steps. In total they had five fruit trees which were growing both in the back and front yard. The size of the trees did not differ greatly (figure 22).

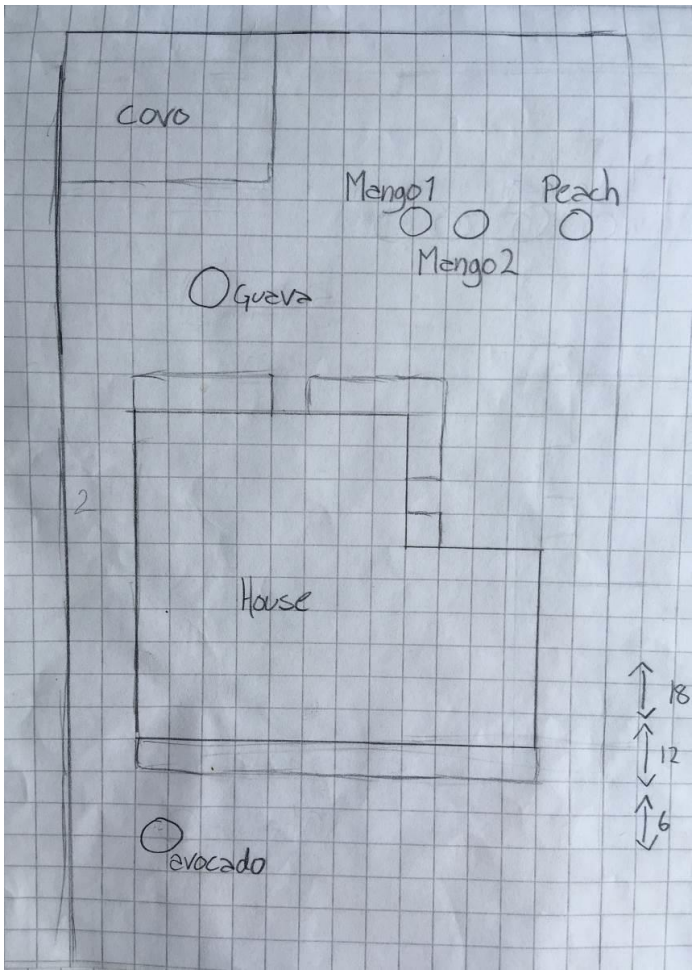


Figure 21. Location of the fruit trees from the interview number 34.

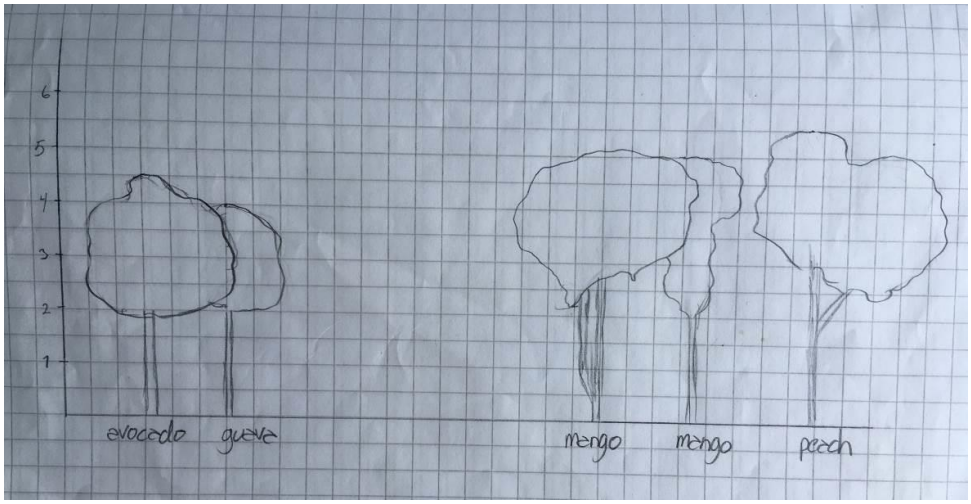


Figure 22. Canopy profile from the interview number 34.

6 DISCUSSION

The aim of this study was to find out what fruits people are growing in their homegardens in Dzivarasekwa area in Harare and how people use the yield, whether they sell the fruits or use them for their own consumption. Above this, answers to the three hypotheses stated at the beginning of this research project were to be found. For this, 34 interviews were conducted with local citizens in their homegardens. The following paragraphs discuss about the findings of the case study and reflect those to previous studies.

6.1 The role of fruit trees in improving livelihoods

The first hypothesis was that the fruits that people are growing in their homegardens are primarily for the family's own use. This assumption also reflects the current state of research in this field (for instance Kumar and Nair 2004) and can be confirmed since the findings of this thesis show that all the households used the fruit for home consumption.

Homegardens are smaller than conventional agricultural areas, but there might be more species (Landon-Lane 2011). In this case study it was also seen that the homegardens in the peri-urban area were often quite small, so people did not have as much space they maybe would have liked to have. This was also the strongest limiting factor why people did not have more fruit trees growing according to their answers. It was logical that there were more small and medium sized homegardens than large ones in this peri-urban area. Also, like expected, large homegardens had more fruit trees growing than in the small ones. On the other hand, there was still often some free space in the gardens and in many of them, it would have been possible to grow more trees.

When checking the statistical analyses about the size of the homegarden and number of fruits in total, it was possible to see that the larger the homegarden was, the more they had fruit trees growing there. The difference was clearer between the small and the large homegarden, but difference between small and medium sized homegarden was not notable. Therefore, it should be possible to add fruit trees at least in some of the gardens.

In the interviewed gardens the number of different fruit species per household was surprisingly almost the same between the different groups (small, medium, large). This shows that people do not automatically have more species growing in their homegardens when they have more space.

According to different researches (Galhena et al. 2013; Kiptot et al. 2014) women are often taking care of the homegardens and bringing new species there (Kumar and Nair 2004). In this research in more cases women were taking care of the homegardens (women 17, men 12 and both 2), but the gender did not have any impact for the number of fruit species growing in the gardens in this study.

According to the answers most of the people, no matter of the gender, would be ready to grow new species in their garden if there were seedlings available. Also knowing the benefits for the health when having diverse diet, might encourage people to have more different kind of fruit species.

The second hypothesis is that the fruit trees that are grown in the homegardens bring the family an additional income. Homegardens can improve household's financial situation (Linger 2014) which improves family's cash income (Galhena et al. 2013). In the study area less people had enough fruits to sell them than it was expected. The reason why only 23.5% of the households sold fruits was because of latter limited space reason. People could not grow so many fruit trees that there would be enough extra fruits for sale because families were big enough compared to the size of the gardens and therefore they used mostly all the fruits for the nutrition of the family.

Most of the people were however ready to grow more fruit trees and sell the fruits in the local markets if the space was not limited. Couple of households also told the problem was that they did not have the seedlings that they could grow more trees. This showed that the fruit trees could bring additional income to the family if there was more space for fruit trees to grow and people had the seeds or seedlings of the trees.

The main reason why people do not have more fruit trees growing in their homegardens is space like mentioned before. This could be solved by using more public land for the cultivation of trees in the Dzivarasekwa area. There is still space next to the streets and in the outside areas of the district that could be used more efficiently. This kind of decision might need some policy changes.

The Zimbabwe Aids Orphans society's forestry project could also use some of their land to extend the orchard for producing fruit tree seedlings for the community which could be then planted for the public areas and for the agroforestry project area. Also, it would be good if it would be possible to extend this agroforestry area which is rent from the city of Harare. In this way, more people could get a plot. People who have already a plot in the project area could also grow fruit trees in the same field where they grow other trees and crops. This would bring more nutrition for the local people (Akinnifesi et al. 2004) and would increase species diversity in the area.

Pye-Smith (2008) has reported how vitamins, minerals and other substances that people get from fruits are mandatory to people's health. It is also said that nutrition is one the most important things that affects the wellbeing and health of people (Karttunen et al. 2014). All the interviewed households also thought that fruits constitute an important part of their daily diet. Some people mentioned how their doctor recommended them to eat fruits because they are healthy. This showed people understand the importance of the fruits as part of their nutrition.

Nevertheless, the daily diet of the interviewed households was often quite simple and consisted of lots of carbohydrates because people were eating lots of maize porridge and white bread. Not all the households were eating fruits daily even though they knew the importance of them. By adding more fruits in people's daily diet, they would get more necessary vitamins and other nutrients which would improve their health and in addition to this also improve food and nutrition security. For example, mango consists of vitamin A which would lower the risk of some eye diseases (Landon-Lane 2011; Shah and Strong 1999).

The third hypothesis is that fruits which are produced in the homegardens can produce food for the family, year-round or at least during a certain period. The

results show that fruit trees grown in the homegardens can produce fruits for the household for the daily diet all over the year. This was seen because some of the fruit trees like banana and papaya are producing fruits the whole year around (Rice et al. 1987) and in some homegardens of Dzivarasekwa people were growing these fruit trees. If people would grow more of these fruit tree species, or some other which gives fruits around the year, people could diversify their daily diet and get vitamins all over the year from the fruits grown in their own garden. This would give stability for the food supply of the households (FAO 2001).

However, at that moment most of the fruit trees gave the yield from December until February which is the time people get more fruits on their own. This would be also the main season to sell the fruits in the local markets. Fruit sales could then bring extra income needed to the household (Galhena et al. 2013), especially at the end or beginning of the year.

In the descriptive maps of the five interviewed households it was seen that fruit trees of the homegardens had different canopy layers like also Mbow et al. (2013) told. However, this depended on what fruit species people were growing and how old they were. On the other hand, there might be also still the possibility of growing more fruit trees in peoples' homegardens since in many other parts of the world fruit trees grown in the homegardens are growing by using more canopy layers. For example, if comparing to Javanese homegardens which are very rich in species and they grow in up to five canopy layers (Michon 1983), in Dzivarasekwa area homegardens are still quite spacious. Of course, climate conditions are different in Zimbabwe than in Indonesia, which then also affects diversity and complexity of the homegardens (Landon-Lane 2011) and this needs to be taken into account when planning the structure of the gardens.

Before the interviews mango and avocado were expected to be the most common fruit trees cultivated in the Dzivarasekwa homegardens based on people's previous visits in the area. This was also noticed during the interview process since mango grew in 85.3% of the homegardens and avocado in 64.7% homegardens making these the top two fruit tree species of the interviewed

households. Above that, it came as a surprise that peach, guava and IFT species were so popular in the research area.

Mangoes which were sold in the local markets of Dzivarasekwa, were very fibrous. Because of this, they were very difficult to eat. That is a reason why it would be good to graft better mango varieties for the local people of Dziwarasekwa. Detailed information already exists at ICRAF (Griesbach 2003) about different mango varieties, their properties and management, including listing of varieties which produce parthenocarpic seeds and therefore need not be grafted for maintaining the clonal characteristics.

When having better varieties, people might be even more eager to grow and eat these fruits. It is also possible to get better price from those improved varieties or produced outside the normal fruiting season. Also 33 households told they would be interested to grow better varieties if they were available. This would then help to nourish the local people. Propagating for example better mango varieties could be possibly done in the forestry project's orchard with the help of specialists. This is one way how the Finnish aid organization could help also the local people of Dzivarasekwa who are not part of this project.

6.2 Indigenous fruit trees as part of agroforestry systems

Even though Benhura et al. (2013) have concluded how people in Zimbabwe like to collect and consume indigenous fruits and Moir et al. (2007) have reported that indigenous fruit trees can provide nutrition and cash income both in urban and rural areas, it was not expected that people are growing so many IFTs in their homegardens of the peri-urban study area. The fact that few households were growing IFTs showed that it is not impossible to cultivate these fruit trees in the homegardens. Nevertheless, some other interviewed people were a bit suspicious how the IFTs would grow in the homegarden areas since they are wild fruit trees. In this case sharing experiences might encourage other local people to try to grow indigenous fruit tree species as well.

In the future, more attention should be paid for the domestication of IFTs since these fruits clearly approve households' livelihoods (Moir et al. 2007). IFTs

could help especially poor people and be an important source of nutrition in emergency situations (Akinnifesi et al. 2006). Akinnifesi (2004) has suggested that domestication of these fruit tree species could be a solution for food demand, which Africa will face in the near future (Garrity et al. 2010). Because some indigenous fruits are also available in the times of the year that other fruit trees are not giving yield, growing these trees would support food and nutrition security in the area. Domestication of few IFT species could help the people to earn money by selling these fruits in the local markets or even in the city center area.

These fruits would also bring more variation for their daily diet in Dzivarasekwa area. Nyanga et al. (2013) has mentioned that IFTs in right amounts can even have higher amount of nutrition than some other more common fruit species. That is a reason why it would be important to tell people more about the health benefits of these fruits. Maybe it would be easier for them to take indigenous fruit trees to their production, if somebody else would first domesticate them and promote these trees. Especially it would be good to grow more IFTs in the area because people are interested about them and they are also a good source of nutrition like stated above. Also, adding IFT species to the forest project area and people’s homegardens would diversify the number of species found in the area. In the forest area this would help to reconstruct Miombo forests.

7 CONCLUSIONS

People in Dzivarasekwa are growing many different kinds of fruit trees in their homegardens. The most common species in the area, mango and avocado, were expected to be popular, but interestingly, also indigenous fruit trees were growing in some of the homegardens. This shows it is not impossible to grow indigenous fruit trees in the homegardens. Many interviewed households were interested to grow indigenous fruit tree species in their homegardens in the future, if there are seedlings available. This is why more attention should be paid to the role of indigenous fruit tree species as a part of daily nutrition. Indigenous fruit trees would help to improve the productivity of the agroforestry area and would reconstruct Miombo forests at the same time.

From the interviewed households all of them used fruits as a part of nutrition as it was supposed, but only eight households also sold fruits to get income. Especially small size of the homegardens was limiting to grow fruit trees, which also restricted sales because households were big and for this reason they did not have enough fruits for sale. That is why selling fruits did not have a remarkable role for the interviewees' households. However, people would have been interested to grow more different kind of fruit trees and to sell them which could bring additional income for the families.

The results show that fruit trees grown in Dzivarasekwa area can produce fruits for the household for the daily diet all over the year, depending on the species grown. For the moment, most of the interviewed people get yield a few months in a year, during rainy summer season. If people were to grow more diverse species, it would ensure better access to food throughout the year.

Few households mentioned that they did not have more fruit trees because they have no seedlings. People would have been also interested in new and improved (e.g. grafted) cultivars if they would have the seedlings. When extending the orchard of the forestry project, attention should be given to demonstration of different fruit tree species and varieties, and to providing improved propagation material, so as to facilitate the production of a wider range and larger quantity of fruits for the benefit of the people in Dzivarasekwa.

REFERENCES

Agyapong, E.B., Ashiagbor, G., Ayine Nsor, C. & van Leeuwen, L.M. 2018. Urban land transformation and its implication on tree abundance distribution and richness in Kumasi, Ghana. Journal of Urban Ecology 4(1): 1-11.

Akinnifesi, F.K., Kwesiga, F.R., Mhango, J., Mkonda, A., Chilanga, T., Swai, R. 2004. Domesticating Priority for Miombo Indigenous Fruit Trees as a Promising Livelihood Option for Small-holder Farmers in Southern Africa. ICRAF.

Akinnifesi, F.K., Kwesiga, F., Mhango, J., Chilanga, T., Mkonda, A., Kadu, C.A.C., Kadzere, I., Mithofer, D., Saka, J.D.K., Sileshi, G., Ramadhani, T., Dhliwayo, P. 2006. Towards the development of miombo fruit trees as commercial tree crops in Southern Africa. Forests, Trees and Livelihoods 16: 103-121.

Atangana, A. Khasa D., Chang, S., Degrande, A. 2014. Tropical Agroforestry. Springer.

Benhura, M., Muchuweti, M., Gombiro, P.E., Benhura C. 2013. Properties of (Parinari curatellifolia) (Hacha or Chakata) fruits from different parts of Harare, Zimbabwe. African Journal of Food, Agriculture, Nutrition and Development 13(4): 8004-8018.

CIA – The World Factbook. https://www.cia.gov/library/publications/the-world-factbook/geos/zi.html Referred September 2018.

Deheuvels, O., Avelino, J., Somarriba, E., Malezieux, E. 2012. Vegetation structure and productivity in cocoa-based agroforestry systems in Talamanca, Costa Rica. Agriculture, Ecosystems & Environment 149: 181-188.

FAO 1996. Report of the World Food Summit. Food and Agricultural Organisation of the United Nations, Rome.

FAO 2001. Global Forest Resources Assessment 2000 - Main report. FAO forestry paper 140. The Chief, Publishing and Multimedia Service, Information Division, Rome, Italy.

FAO 2001. Urban and peri-urban agriculture: A briefing guide for the successful implementation of Urban and Peri-urban Agriculture in Develping Countries and Countries of Transition. 1. Edition. The Special Programme for Food Security.

FAO 2006. Food security. Policy Brief 2. http://www.fao.org/fileadmin/templates/faoitaly/documents/pdf/pdf_Food_Security_Cocept_Note.pdf

FAO 2012. Country profiles - Zimbabwe. http://www.fao.org/countryprofiles/index/en/?iso3=ZWE Referred 24.05.2018.

FAO (Food and Agricultural Organization of the United Nations), IFAD (International Fund for Agricultural Development), WFP (World Food Programme). 2013. The State of Food Insecurity in the World 2013. The Multiple Dimensions of Security. Rome: FAO.

Forestry Commission of Zimbabwe. 1996. Map of Harare vegetation types. Wallpaper published by forestry commission of Zimbabwe. Harare, Zimbabwe.

Galhena, D.H., Freed, R., Maredia, K.M. 2013. Home gardens: a promising approach to enhance household food security and wellbeing. Agriculture & Food Security 2: 37.

Garrity, D.P., Akinnifesi, F.K., Ajayi, O.C., Weldesemayat, S.G., Mowo, J.G., Kalinganire, A., Larwanou, M., Bayala, J. 2010. Evergreen Agriculture: a robust approach to sustainable food security in Africa. Food Security 2: 197–214.

Goenster, S., Wiehle, M., Kehlenbeck, K., Jamnadass, R., Gebauer, J., Buerkert, A. 2011. Indigenous fruit trees in homegardens of the Nuba Mountains, Central Sudan: tree diversity and potential for improving the nutrition and income of rural communities. Acta Horticulturae 911: 355-364.

Griesbach, J. 2003. Mango growing in Kenya. ICRAF. Nairobi, Kenya. 117 p.

Guedes, B.S., Olsson, B.A., Karltun, E. 2016. Effects of 34-year-old *Pinus taeda* and *Eucalyptus grandis* plantations on soil carbon and nutrient status in former miombo forest soils. Global Ecology and Conservation 8: 190-202.

High, C., Shackleton, C.M. 2000. The comparative value of wild and domestic plants in homegardens of a South African rural village. Agroforestry Systems 48: 141–156.

ICRAF 2018. Agroforestry and our role. http://www.worldagroforestry.org/about/agroforestry-our-role Referred 13.5.2018.

Issah, G., Kimaro, A.A., Kort, J., Knight, J.D. 2014. Quantifying biological nitrogen fixation of agroforestry shrub species using 15N dilution techniques under greenhouse conditions. Agroforestry Systems August 88: 607–617.

Kabunga, N., Ghosh, S., Griffiths, J. K. 2014. Can Smallholder Fruit and Vegetable Production Systems Improve Household Food Security and Nutritional Status of Women? Evidence from Rural Uganda. IFPRI Discussion Paper 01346.

Kalinganire, A., Weber, J.C., Coulibaly, S. 2012. Improved *Ziziphus Mauritiana* germplasm for Sahelian smallholder farmers: First steps toward a domestication programme. Forests, trees and livelihoods 21 (2): 128-137.

Karttunen, K., Kihlström, L., Taivalmaa, S. 2014. Nälkä ja yltäkylläisyys. Gaudeamus Oy. 253 p.

Kehlenbeck, K., Asaah, E., Jamnadass, R. 2013. Diversity of indigenous fruit trees and their contribution to nutrition and livelihoods in sub-Saharan Africa: examples from Kenya and Cameroon. In book: Fanzo, J., Hunter, D., Borelli, T., Mattei, F. (ed.). Diversifying Food and Diets. Using Agricultural Biodiversity to Improve Nutrition and Health. Earthscan Routledge, New York. pp. 257-269.

Kiptot, E., Franzel, S., Degrande, A. 2014. Gender, agroforestry and food security in Africa. Current Opinion in Environmental Sustainability 6: 104-109.

Korkalo, L., Freese, R., Alfthan, G., Fidalgo, L., Mutanen, M. 2015. Poor micronutrient intake and status is a public health problem among adolescent Mozambican girls. Nutrition research 35: 664-673.

Kumar, B.M., Nair, P.K.R. 2006. Tropical Home Gardens: A Time-Tested Example of Sustainable Agroforestry. Springer, Netherlands. 379 p.

Kumar, B.M., Nair, P.K.R. 2004. The enigma of tropical homegardens. Agroforestry Systems 61: 135–152.

Landon-Lane, C. 2011. Livelihoods Grow in Gardens. FAO Diversification booklet number 2. 2. Edition. Rural Infrastructure and Agro-Indstries Division, Food and Organization of the United Nations, Rome.

Linger, E. 2014. Agro-ecosystem and socio-economic role of homegarden agroforestry in Jabithenan District, North-Western Ethiopia: implication for climate change adaptation. SpringerPlus 3: 154.

Luke 2018. Results booklet, FoodAfrica Improving Food Security in West and East Africa. Ministry of Foreign Affairs in Finland.

Mamombe, V., Kim, VM., Choi, Y-S. 2016. Rainfall variability over Zimbabwe and its relation to large-scale atmosphere-ocean processes. International Journal of Climatology 37(2): 963-97.

Maroyi, A. 2009. Traditional homegardens and rural livelihoods in Nhema, Zimbabwe: a sustainable agroforestry system. International Journal of Sustainable Development and World Ecology 16(1):1-8.

Maroyi, A. 2011. Potential role of traditional vegetables in household food security: A case study from Zimbabwe. African Journal of Agricultural Research 6: 5720-5728.

Maroyi, A. 2013. Use and management of homegarden plants in Zvishavane district, Zimbabwe. Tropical Ecology 54(2): 191-20.

Mbiba, B. 1999. Urban agriculture in Harare: between suspicion and repression. City case study. Resource Centre on Urban Agriculture and Forestry, Leusden, Netherlands.

Mbow, C., van Noordwijk, M., Luedeling, E., Neufeldt, H., Minang, P.A. & Kowero, G. 2013. Agroforestry Solutions to Address Food Security and Climate Change Challenges in Africa. Current Opinion in Environmental Sustainability 6: 61–67.

Mbow, C., Bustamante, M., Duguma, L.A., Skole, D., Smoth, P. 2014. Achieving mitigation and adaptation to climate change through sustainable agroforestry practices in Africa. Current Opinion in Environmental Sustainability 6: 8-14.

Mekonen, T., Giday, M., Kelbessa, E. 2015. Ethnobotanical study of homegarden plants in Sebeta-Awas District of the Oromia Region of Ethiopia to assess use, species diversity and management practices. Journal of Ethnobiology and Ethnomedicine 11: 64.

Michon, G. 1983. Village-Forest-Gardens in West Java. In: Huxley, P.A. (ed.). Plant Research and Agroforestry: 13–24. ICRAF. Nairobi, Kenya.

Moir, K., Vandenbosch, T., Scull-Carvalho, S. 2007. Growing Trees and Gardens for life: Practical tips for healthy tree nurseries and homegardens. Printed in Nairobi, Kenya. Jacaranda Design Ltd. 89 p.

Nagy, S., Shaw, P.E. 1980. Tropical and subtropical fruits, composition, properties and uses. The Avi Publishing, Inc. Westport, Connecticut. 532 p.

Nawrotzki, R.J., Robson, K., Gutilla, M.J., Hunter, L.M., Twine, W., Norlund, P. 2014. Exploring the impact of the 2008 global food crisis on food security among vulnerable households in rural South Africa. Food Security 6: 283–297.

Ngadze, R. T., Verkerk, R., Nyanga, L.K., Fogliano, V., Linnemann, A.R. 2017. Improvement of traditional processing of local monkey orange (Strychnos spp.) fruits to enhance nutrition security in Zimbabwe. Food Security 9(3): 621-633.

Nyanga, L.K., Gadaga, T.H., Nout, M.J.R., Smid, E.J., Boekhout, T., Zwietering, M.H. 2013. Nutritive value of masau (Ziziphus mauritiana) fruits from Zambezi Valley in Zimbabwe. Food Chemistry 138(1): 168-172.

Nyoka, B.I., Rukuni, D. 2000. Progress with domestication of indigenous fruit tree species in Zimbabwe. In: Shumba, E.M., Lusepani, E., Hangula, R. (ed.) Proceedings of the SADC Tree Seed Centre Network Techincal Meeting. SADC Tree Seed Centre Network, FAO & CIDA Canadian International Development Agency. Windhoek, Namibia. pp. 62-66.

Pye-Smith, C. 2008. Farming Trees, Banishing Hunger: How an agroforestry programme is helping smallholders in Malawi to grow more food and improve their livelihoods. ICRAF. Nairobi, Kenya.

Rice, R.P., Rice, L.W., Tindall, H.D. 1987. Fruit and vegetable production in Africa. Macmillan, England. 371 p.

Ross, J.S., Harvey, P.W.J. 2003. Contribution of breastfeeding to vitamin A nutrition of infants: a simulation model. World Health Organization Bulletin of the World Health Organization 81(2): 80.

Shah, M., Strong, M. 1999. Food in the 21 century-from science to sustainable agriculture. Washington, D.C. The World Bank. 72 p.

Simelton, E.S., Catacutan, D.C., Dam, B.V., Dao, T.C., Le, T.D. 2016. Factors constraining and enabling agroforestry adoption in Viet Nam: a multi-level policy analysis. Agroforestry Systems 91: 51-67.

Tauqueer, A., Prachi, M. S., Sujit, K.J. 2016. Estimation of area under agroforestry using high resolution satellite data. Agroforestry Systems 90: 289–303.

UN 2015. World population prospects: the 2015 revision, key findings and advance tables. Department of Economic and Social Affairs. United Nations, New York.

UNSCN 2010. 6th Report on the world nutrition situation: Progress in nutrition. United Nations System – Standing Committee on Nutrition, Geneva, Switzerland.

Van Wyk, B. 2006. Food plants of the World: An illustrated guide. Timber Press, Portland. 480 p.

Venter, F., Venter, J-A. 2009. Making the most of Indigenous Trees. Briza Publications, Pretoria, South-Africa.

Venter, S.M., Witkowski, T.F. 2011. Baobab (Adansonia digitata L.) fruit production in communal and conservation land-use types in Southern Africa. Forest Ecology and Management 261: 630-639.

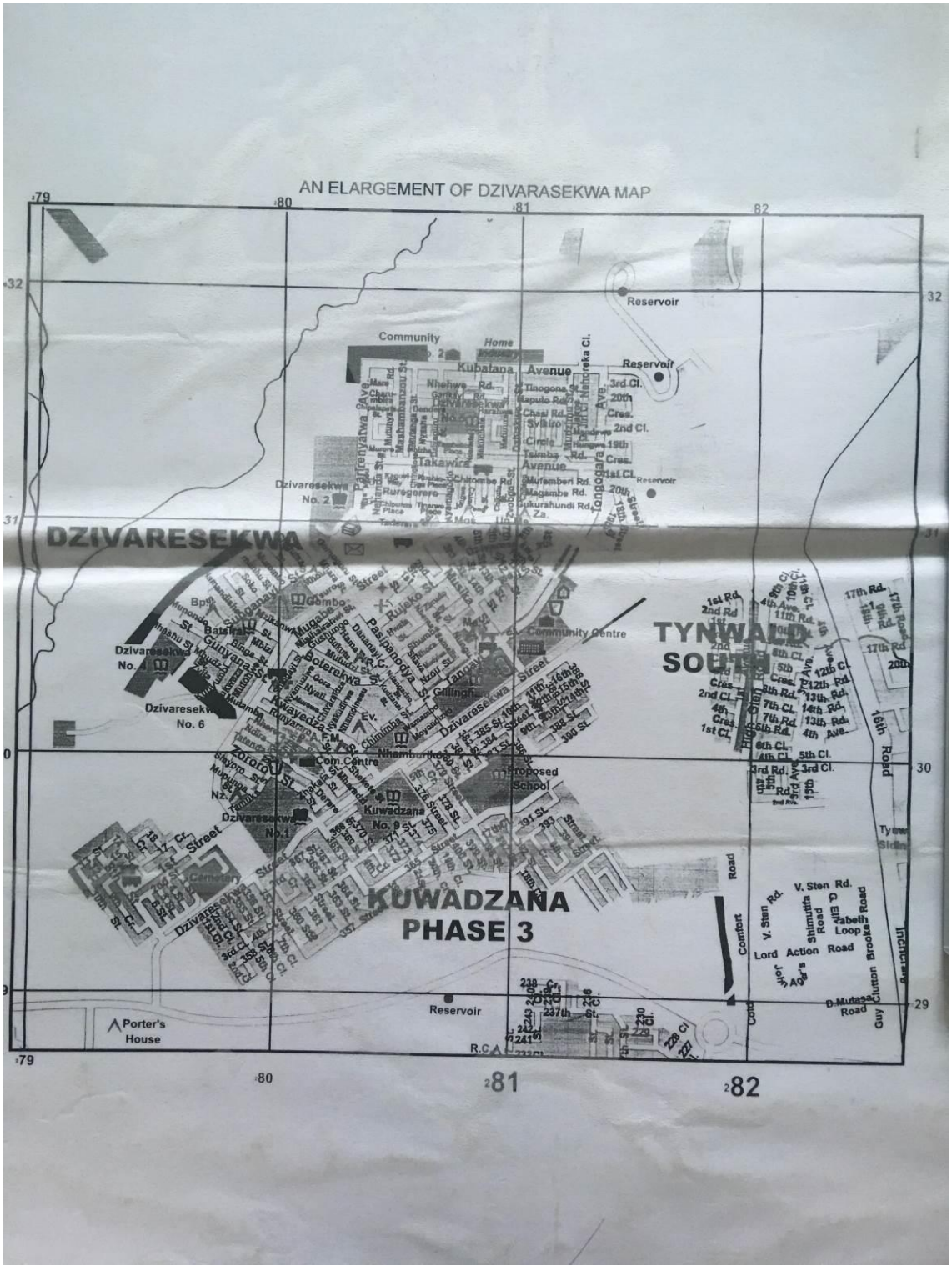
Vähätalo, L., Mikkilä, V., Räsänen, L. 2005. Schoolchildren's food consumption and dietary intake during the dry season in north-west Namibia. International Journal of Food Sciences and Nutrition 56(6): 367-375.

Ward, M. 2011. The case for evergreen agriculture in Africa: enhancing food security with climate change adaptation and mitigation in Zambia. Climate & Knowledge Development Network. Inside Stories on climate compatible development.

Zimbabwen Aids-Orvot ry. 2018. Zimbabwe Aids Orphans Society. Referred August 2018. https://www.zim-orvot.org/

ANNEX 1 Map of the research area

The map shows the research area excluding Dzivarasekwa Extension which was situated in the northwest of the displayed area and is not visible on this map.



ANNEX 2 Questionnary

Interview of local people who have homegarden

Date:

Interpreter:

Site:

GPS location:

How many people are in the household? Names and ages who are living at the house.

Homegarden

Fruit tree species:

Crop (including vegetables) species:

Tree species:

Other plants:

Size of the homegarden:

How have you invested to agriculture or garden?

Who is responsible about the homegarden? Who is doing the garden works?

Do you have land in the Dzikwa project area?

Do you have land somewhere else? If yes, how much?

Fruit tree species

What is the purpose of the fruit trees in your homegarden?

Where did you get the seeds/seedlings?

When do the trees start to give fruits? How long time does the tree give fruits?

Do you get more than one yield per year?

How big yield do you get?

Is the yield enough for your family's daily need?

How do you use the yield? home consumption for food/selling/other (forage, medical)

If selling, where do you sell them?

How old are the fruit trees? Are you planning to get new ones when they will die?

What varieties are the fruit trees? Are the varieties improved? For example grafted.

Would you like to have improved varieties from those species you know already if they would be available? Better yield/better taste/disease-resistant

Have you tried to grow other species before? What? Why not anymore?

What is the biggest reason that you don't have more fruit trees growing at the moment?

Would you be ready to try new species if there would be seedlings available?

What fruits would you be ready to grow and eat?

If you would grow more fruit trees how would you use the yield?

Do you buy fruits? What and where? If not, why not? (too expensive, other reason)

Does the price ever affect to your decision to buy fruits?

Who eats fruits in the household?

How much do you eat fruits daily/weekly? What species?

What fruits do you eat in different seasons? Summer/winter

Do you think fruits are important or unimportant in your daily diet? Why or why not?

What other fruit species do you know?

Do you use fruits that are naturally growing in the nature/forest? If yes, where do you get them?

Would you like to grow them also in your homegarden or in some other cultivation area?

What time of the day do you eat and what do you eat in each meal?

How many people are eating daily? minimum____ maximum____

What are you using as household energy?

<u>If firewood:</u>

What do you normally use as firewood?

Where do you get your firewood?

Do you own the house? If yes, do you rent rooms?

How many people are working in the family?

ANNEX 3 Fruit tree species mentioned in the interviews

Scientific name	Common name	Shona name
Adansonia digitata L.	Baobab	Mawuyu
Ananas comosus (L.) Merr.	Pineapple	Nanazi
Annona senegalensis Pers.	Wild custard apple	Muroro
Azanza garckeana (F.Hoffm.) Exell & Hillc.	Snot apple	Matohwe
Berchemia discolor (Klotzsch) Hemsl.	Birdplum	Nyii
Carica papaya L.	Papaya	Papaw
Carissa edulis Vahl.	Simple-spined num-num	Nzambara
Citrus limon (L.) Osbeck	Lemon	Ndimu
Citrus sinensis (L.) Osbeck	Orange	Ranjisi
Flacourtia indica (Burm. f.) Merr.	Governor's plum	Nhunguru
Litchi chinensis Sonn.	Lychee	Litchi
Malus domestica Borkh.	Apple	Apuro
Mangifera indica L.	Mango	Mango
Morus alba L.	White mulberry	Habhurosi
Morus nigra L.	Black mulberry	Habhurosi
Musa sapientum L.	Banana	Mutsoro
Passiflora ligularis A.Juss.	Sweet granadilla	Magrandera
Persea Americana Mill.	Avocado	Avocado
Prunus armeniaca L.	Apricot	Apricot
Prunus domestica L.	Plum	Svazva
Prunus persica (L.) Batsch	Peach	Pichisi
Psidium guajava L.	Guava	Gwavha
Punica granatum L.	Pomegranate	Giranada
Pyrus communis L.	Pear	Pear
Strychnos spinosa Lam.	Trifoliate orange tree	Mutamba
Syzygium cordatum (Hochst.)	Waterberry	Mhute
Uapaca kirkiana Müll.Arg.	Sugar plum	Mazhanje
Vangueriopsis lanciflora (Hiern) Robyns	The false wild medlar	Matufu
Vitex mombassae Vatke	Smell-berry fingerleaf	Tsubvu
Vitex payos (Lour.) Merr.	Chocolate berry	Mutsubvu
Vitis vinifera L.	Grape	Tsambatsi
Ziziphus mauritiana Lam.	Indian plum	Masau

ANNEX 4 Indigenous tree species that provide edible fruits

List of the most common indigenous tree species which can grow in Zimbabwe and provide edible fruits (Venter and Venter 2009).

Scientific name	*Common name*
Adansonia digitata	Baobab
Annona senegalensis subsp. senegalensis	Wild custard-apple
Antidesma venosum	Tassel-berry
Azanza garckeana	Azanza
Berchemia discolor	Brown ivory
Berchemia zeyheri	Red ivory
Boscia albitrunca	Shepherd tree
Bridelia micrantha	Mitzeeri
Carissa edulis	Simple-spined num-num
Carissa macrocarpa	Large num-num
Cassinopsis ilicifolia	Lemon thorn
Celtis africana	White stinkwood
Diospyros mespiliformis	Jackal-berry
Diospyros whyteana	Bladder-nut
Dovyalis caffra	Kei-apple
Dovyalis zeyheri	Wild apricot
Ehretia rigida	Puzzle bush
Englerophytum magalismontanum	Transvaal milkplum
Ficus abutilifolia	Large-leaved rock fig
Ficus burkei	Common wild fig
Ficus glumosa	Mountain fig
Ficus ingens	Red-leaved rock fig
Ficus salicifolia	Wonderboom fig
Ficus sansibarica subsp. Sansibarica	Knob fig
Ficus sur	Broom cluster fig
Ficus sycomorus subsp. sycomorus	Sycomore fig
Garcinia livingstonei	African mangosteen
Grewia flava	Brandy-bush
Grewia hexamita	Giant raisin
Grewia monticola	Silver raisin
Grewia occidentalis var. occidentalis	Cross-berry
Halleria lucida	Tree fuchsia
Harpephyllum caffrum	Wild plum
Ilex mitis. var. mitis	Cape holly
Kigelia africana	Sausage tree
Lannea schweinfurthii var. stuhlmannii	False marula

Mimusops zeyheri	Transvaal red milkwood
Mystroxylon aethiopicum	Kooboo-berry
Olea europaea subsp. africana	Wild olive
Pappea capensis	Jacket-plum
Parinari curatellifolia	Mobola plum
Phoenix reclinata	Wild date palm
Sclerocarya birrea subsp. caffra	Marula
Syzygium cordatum	Water-berry
Vangueria infausta subsp. infausta	Wild medlar
Ximenia caffravar. caffra	Large sourplum
Ziziphus mucronata	Buffalo thorn