

The contribution of trees to local livelihoods in urban areas

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Abstract

Trees in natural forests are widely known for their essential contribution to rural livelihoods in developing countries, providing both consumptive and non-consumptive products to rural inhabitants. These benefits are also obtained from trees in urban forests and used by urban households. In the past decades, the role of urban trees to urban livelihoods, municipalities, local and global environment has often been overlooked by researchers and development agencies, and hence are poorly documented, especially in Africa. In South Africa, the increase in urbanisation and urban poverty means many urban residents are expected to be dependent on trees and tree products from homesteads, neighbourhoods and edges of towns. There is however a paucity of literature on the potential of trees in sustaining livelihoods and poverty alleviation in urban areas. This study determined the magnitude and nature of the direct contribution of trees and tree products to local livelihoods in different urban residential areas (informal, Reconstruction and Development Programme (RDP), and township) in three South African towns (Tzaneen, Bela Bela and Zeerust) which cover a rainfall gradient from relatively higher (775 mm p.a.) to low (575 mm p.a.). The results showed that most (90%) households had an interest in planting and managing trees on homesteads, given the high proportion (71%) of residents who had planted trees on their homesteads. The abundance of trees followed the moisture gradient, with Tzaneen having a larger share (46.4%) of trees, followed by Bela Bela (27.5%) and Zeerust (26.1%). Larger plots in the informal residential area accounted for the larger proportion (42.8%) of trees on homesteads, followed by the township (32.9%) and RDP households being the least because they were recently established. Tree density was also higher in the high rainfall town but the pattern did not follow the moisture gradient between Bela Bela and Zeerust due to little rainfall difference. However, tree density across residential areas was similar to the proportion of trees on homesteads in residential areas. The most common tree species were alien, and mainly exotic fruit trees made up two-thirds of the trees encountered. Most households collected various products from urban trees, particularly fuelwood, from edges of towns. This was especially by households with lower cash income. However, fruits were collected from homesteads regardless of the wealth status. Tree products had a significant contribution to the total annual household income, with fuelwood alone contributing up to R5 663 per household per annum, equivalent to two-three month household cash income. Tree products added 20% to total household income, which represents the amount of money households, save by collecting tree products for free. Therefore, trees within and around urban areas contribute significantly to livelihoods and reduce poverty in urban areas. There is need therefore to encourage urban residents to plant trees on homesteads and policy makers to come up with policies that promote sustainable harvesting of tree products from areas surrounding urban areas.

Key words: Natural forests, urban forests, urban poverty, urbanisation, consumptive, livelihoods.

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Dedication

I whole heartedly dedicate this thesis to my dear friends and family for their love, motivation, encouragement, moral and financial assistance. This is the product of their contribution without them this would not have been achieved.

Table of contents

Abstract	i
Acknowledgement	ii
Dedication	ii
Table of contents	iii
List of tables	vii
List of figures	viii
Acronyms	ix
Preface	x
Chapter One: Introduction and study area	1
1 Introduction	1
1.1 Causes of urbanisation in developing countries	2
1.2 Effects of urbanisation in developing countries	2
1.3 Natural resource use, poverty alleviation and rural livelihoods	4
1.4 Benefits of urban forests	6
1.5 Supply of tree products	7
1.6 Factors affecting trees and tree products	8
1.7 Urban residential areas	8
1.8 Household and urban forest characteristics	11
1.9 Research gap	12
1.10 Objective	12
2 Study area	12
2.1 Tzaneen	14
2.1.1 Population size	15
2.1.2 Housing status	15
2.1.3 Economic status	15
2.1.4 Literacy levels	16
2.1.5 Vegetation and climate	16
2.2 Bela Bela	16
2.2.1 Population size	17
2.2.2 Housing status	17
2.2.3 Economic status	17
2.2.4 Literacy levels	18
2.2.5 Vegetation and climate	18
2.3 Zeerust	19
2.3.1 Population size	19

2.3.2 <i>Housing status</i>	19
2.3.3 <i>Economic status</i>	20
2.3.4 <i>Literacy levels</i>	20
2.3.5 <i>Vegetation and climate</i>	20
Chapter Two: The abundance, distribution, richness and attributes of homesteads trees in different urban residential areas	22
1 Introduction	22
2 Methods	25
2.1 <i>Pilot study</i>	25
2.2 <i>Sampling</i>	25
2.3 <i>Trees in homesteads</i>	25
2.4 <i>Carbon content</i>	26
2.5 <i>Use of trees and tree products</i>	26
2.6 <i>Observation and note taking</i>	26
3 Data analysis	27
4 Results	27
4.1 <i>Homestead plot size</i>	27
4.2 <i>Distribution of trees on homesteads</i>	28
4.3 <i>Tree density</i>	29
4.4 <i>Tree basal circumference at basal height</i>	30
4.5 <i>Carbon content in trees on homesteads</i>	30
4.6 <i>Tree species richness</i>	32
4.7 <i>Tree establishment</i>	32
4.8 <i>Dominant tree species</i>	33
4.9 <i>Indigenous and alien tree species on home plots</i>	33
4.10 <i>Trends in tree abundance over the past five years</i>	34
4.11 <i>Relationships between household and tree attributes</i>	36
5 Discussion	38
5.1 <i>Characteristics of tree holdings on urban homesteads</i>	38
5.2 <i>Tree attributes</i>	41
Chapter Three: Uses of trees and tree products by urban households in different residential areas	43
1 Introduction	43
1.1 Consumptive tree products	44
1.1.1 <i>Fuelwood</i>	44
1.1.2 <i>Fruits</i>	45
1.1.3 <i>Wood for building, fencing and household tools</i>	46

1.1.4 Medicines	46
2 Methods	47
3 Data analysis	48
4 Results	48
4.1 Major tree products	49
4.1.1 Fuelwood collected on homesteads	49
4.1.2 Fuelwood collected from other places	49
4.1.3 Fuelwood bought from traders and supermarkets	51
4.1.4 Fruits collected on homesteads	52
4.1.5 Fruits collected from other places	53
4.1.6 Fruits bought from traders and supermarkets	54
4.2. Minor tree products	56
4.2.1 Wood for building	56
4.2.2 Wood for fencing	56
4.2.3 Herbal medicines	57
4.2.4 Other minor tree products	57
4.2.5 Household attributes influencing the use of tree products	58
5 Discussion	60
5.1 Fuelwood	62
5.2 Fruits	63
5.3 Wood for building	65
5.4 Other tree products	66
Chapter Four: The direct-use value of tree products used by urban households	68
1 Introduction	68
1.1 The direct-use value of consumptive tree products	68
2. Methods	70
2.1 Direct-use value	70
3 Data analysis	70
4 Results	71
4.1 Quantities of fuelwood collected and bought per annum	71
4.2 Direct-use value of fuelwood collected from homesteads	72
4.3 Direct-use value of fuelwood collected from other places	72
4.4 Fuelwood bought per household	73
4.5 Direct-use value of fruits from own homesteads	73
4.6 Direct-use value of fruits from other places	73
4.7 Fruits bought per household	74
4.8 Direct-use value of wood for building	75

4.9	<i>Quantity and direct-use value of wood for fencing</i>	76
4.10	<i>Total household cash income</i>	77
4.11	<i>Contribution of trees and tree products to total household income</i>	77
5	Discussion	79
5.1	<i>Direct-use value of tree products</i>	79
5.2	<i>Household income</i>	82
	Chapter Five: Synthesis, conclusions and recommendations	84
1	Introduction	84
2	What is the abundance, distribution, richness and attributes of homestead trees in different urban residential areas?	85
3	What are the tree products that urban households collect and use from trees on homesteads, other places and buy from traders?	88
4	What is the direct-use value of tree products used by urban communities?	91
5	Conclusion	93
6	Recommendations	94
	References	96
	Appendices	110
	<i>Appendix 1: Interview schedule</i>	110
	<i>Appendix 2: Household profile</i>	134

List of tables

Table 2.1: Homestead plot and tree attributes	28
Table 2.2: Mean (\pm sd) tree density per hectare for the three towns and residential areas	30
Table 2.3: The mean (\pm sd) above ground homestead tree carbon per household and carbon per hectare in kg	32
Table 2.4: Modes of tree establishment	33
Table 2.5: The seven most common tree species for three towns	35
Table 2.6: Percentage of responses on trends in tree abundance in the past five years	36
Table 3.1: Mean (\pm sd) frequency for fuelwood collection and buying per month	50
Table 3.2: Percentage of households collecting the top seven fruit species on own homesteads and mean (\pm sd) frequency per month	53
Table 3.3: Percentage of households collecting the top seven fruits from other places and mean (\pm sd) frequency per month	54
Table 3.4: Percentage of households buying fruits and mean (\pm sd) frequency	55
Table 3.5: The percentage (%) of households collecting and buying minor tree products on own homesteads, other places and supermarkets/traders	57
Table 3.6: The mean (\pm sd) frequency and quantity of households collecting and buying wood for building	58
Table 4.1: Mean (\pm sd) price of tree products per unit	70
Table 4.2: Sources of fuelwood for three towns based on the quantity collected per annum	71
Table 4.3: The mean (\pm sd) annual quantity and annual direct-use value of fuelwood from three different sources	72
Table 4.4: The mean (\pm sd) annual quantity and annual direct-value of fruits on homesteads, other places and bought	74
Table 4.5: The mean (\pm sd) annual quantity and annual direct-use value of wood for building	76
Table 4.6: The mean (\pm sd) annual quantity per year and annual direct-use value of wood for fencing	77
Table 4.7: Mean (\pm sd) total annual cash income for households	78
Table 4.8: Total cash and tree product contribution to household income per year	78
Table 4.9: Total cash and tree product contribution to household income per year	78

List of figures

Figure 1.1: Photographs of the three types of residential areas in South Africa	10
Figure 1.2: The three study towns (Tzaneen, Bela Bela and Zeerust) in South Africa	14
Figure 2.1: Percentage of trees less than 40 cm tall in three towns	29
Figure 2.2: Size class profile of trees	31
Figure 2.3: PCA vector plot of tree and household attributes	37
Figure 3.1: Percentage of households collecting fuelwood on their homesteads	49
Figure 3.2: Percentage of households collecting fuelwood from other places	51
Figure 3.3: Proportion of households buying fuelwood	52
Figure 3.4: Percentage of households collecting fruits on own homesteads	52
Figure 3.5: Percentage of households collecting fruits from other places	55
Figure 3.6: PCA vector plot for collecting tree products and household attributes	59

Acronyms

ABGB	Above ground biomass
AIDS	Acquired Immunodeficiency Syndrome
ANC	African National Congress
ANOVA	Analysis of variance
CIFOR	Centre for International Forestry Research
CSG	Cultural Strategy Group
DBH	Diameter at breast height
GDP	Gross Domestic Product
IDP	Integrated Development Plan
HIV	Human Immunodeficiency Virus
MEA	Millennium Ecosystem Assessment
NFAP	National Forestry Action Programme
PCA	Principal Component Analysis
PRB	Population Reference Bureau
ProBEC	Programme for Basic Energy and Conservation in Southern Africa
R	South African Rand
RDP	Reconstruction and Development Programme
SA	South Africa
SANPAD	South Africa-Netherlands Research Programme on Alternatives in Development
SNR	School of Natural Resources
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
US\$	United States Dollar
USAID	United States Agency for International Development
Vs	Versus
WOW	War On Want
WRI	World Resource Institute

Preface

This thesis on “the contribution of trees to local livelihoods in urban areas” is made up of five chapters and is written in a paper format. The first chapter forms the introduction and is divided into three sections. The first section looks at urbanisation at global, regional and national levels. This chapter discusses the trends of urbanisation and gives two views on urbanisation in view such as its challenges and opportunities in developing countries. It also introduces urban forestry and its benefits to local people and the environment. It goes on to state the types of residential areas and the state of urban forests in various residential areas in South Africa. It also presents the factors that affect urban forests. The last section in this chapter looks at the objective of the study. The main objective is to determine the magnitude and nature of the direct contribution of trees and tree products to local livelihoods in different urban residential areas. This objective is divided into three key research questions which are: What is the abundance, distribution, richness and attributes of homestead trees in different urban residential areas? What are the tree products that urban households collect and use from trees on homesteads, other places and buy from traders? and What is the direct-use value of tree products used by urban communities?

The second section looks at the three study towns, they form an imaginary moisture graduate in which Tzaneen receives the highest annual rainfall while Zeerust receives the lowest amount while Bela Bela lies in between. It gives details on location of the areas, brief history, the local municipalities in which data was collected and area of the municipality. It goes on to give an account of the demographic information, economic status, housing status, literacy level, vegetation and climate for each town.

Each of the three key research questions is written as a chapter with the aim of publishing all of them. The first examines the abundance, distribution, richness and attributes of homestead trees in urban residential areas. The next reports on the uses of tree products by urban households in different residential areas and the third considers the direct-use value of tree products used by urban households. Each of them starts with an introduction which together with the above chapter acts as literature review. Thereafter the methods used to collect and analyse data are presented followed by results. The discussion accounts for the difference among towns and residential areas, and compared to work in different parts of the world.

The fifth chapter puts together the major findings from the three results chapters. It starts with an introduction, synthesis, conclusion and recommendations. The other parts included after this part is the list of references and appendices.

Chapter One

Introduction and study area

1 Introduction

Urbanisation is a major world phenomenon driving social and environmental change (Hoornweg *et al.*, 2011). Global urbanisation has rapidly increased in the past few decades; consequently the majority of the world's population is classified as urban (Singh *et al.*, 2010). At the beginning of the last century, only 10% of the global population lived in urban areas, now it is 51%, and is expected to further rise to 67% in the next 50 years (Grimm *et al.*, 2008). According to PRB (2012) and UN (2011a) the global population is approximately seven billion and will be over nine billion people by 2050. Therefore, approximately 3.5 billion people were living in urban areas in 2010 (UN-Habitat, 2010). Even though the world today has a majority urban population, urbanisation rates differ considerably from region to region as well as its causes.

The developing world still has a majority rural population (59%) although declining as urbanisation gains ground (UN, 2011b). Therefore, in the next 20 to 30 years, developing countries in Africa and Asia are likely to have a majority of urban residents (Montgomery, 2008; UN, 2011b; UN-Habitat, 2009). Africa is experiencing a growing urban population, a trend observed in the past few decades showing that Africa's urban population has risen from 14.6% in 1950 (Kuchelmeister, 1999) to 40% in 2010 (UN, 2011b). According to UN (2004) in the next few years, the urban population in this continent will constitute 54%. This shows a massive urban population increase in developing countries within a short period of time. However, some countries in Africa have already exceeded that prediction.

Contrary to the general pattern for Africa as whole, South Africa has a higher urbanisation rate, estimated at 56.3% (Lehohla, 2006; Naude and Krugell, 2003; Stats SA, 2008) with a declining rural population. Between 1996 and 2001, half a decade, the rural population decreased by 2.4% (Simbi and Aliber, 2000; Stats SA, 2001). Lehohla (2006) reported that more than three million people migrated into urban areas between 1999 and 2003. Urban migration rates are much faster in South Africa and other developing countries as compared to developed countries (Kuchelmeister, 1999; Palen, 1997; Tattey, 2005). In America and Europe, the favourable economic opportunities in urban areas attracted people to move from rural areas into urban areas (Dutt and Parai, 1994). On the contrary, urbanisation in Africa is due to the harsh conditions prevailing in rural areas, which force people to move to urban areas to search for improved living conditions, despite the low economic activities in African urban areas (Tattey, 2005).

1.1 Causes of urbanisation in developing countries

There are three contributing factors attached to urbanisation, namely, natural population growth, immigration (Baker, 2008; Sivaramakrishman *et al.*, 2005; World Bank, 2011) and absorption of rural areas into urban ones (Lehohla, 2006). Firstly, natural population growth occurs where births outnumber deaths, which can be attributed to better medical care, sanitation and food availability (Baker, 2008; World Bank, 2011). These factors improve the health status of people and result in population growth. Secondly, people may move from other countries (immigrants) to another and settle in urban areas or within the country from rural areas (in-migrants) into urban areas (Baker, 2008; Sivaramakrishman *et al.*, 2005; World Bank, 2011). If the number of immigrants and in-migrants exceed the number of emigrants and out-migrants, urban populations increase. Thirdly, classification of rural areas into urban which can either be due to town expansion, where the existing town meets with its surrounding rural areas and become part of urban areas. In other instances, establishment of new towns in areas which used to be rural causes an increase in populations classified as urban (Lehohla, 2006).

The high levels of poverty in rural areas, coupled with low development, are forcing individuals and households to move from rural areas to look for employment, food, shelter, education, health and sanitation in urban areas (Lehohla, 2006; World Bank, 2011). Nevertheless, migrants with little or no formal education rarely benefit from opportunities available in urban areas in the developing world (Baker, 2008). The democratic transition in South Africa is another reason for the recent high rate of urbanisation. The apartheid government prevented black Africans from leaving their racially defined homelands into cities; hence migration was restricted for many years. However, the post-apartheid (African National Congress) government lifted the restrictions, and black Africans are now free to live anywhere. Consequently, over three million black Africans migrated into urban areas between 1996 and 2001 (Lehohla, 2006). Furthermore, the current government has a strong housing programme under the Reconstruction and Development Programme (RDP), focusing on building large numbers of houses for the black Africans for free (Gilbert, 2004) which has contributed to the influx of poor people into urban areas. Approximately two million houses have been built under this programme (Department of Housing, 2007).

1.2 Effects of urbanisation in developing countries

The effects of urbanisation can be said to be twofold, the first being the multiple problems that come with it and the second reflect the opportunities it offers to people and the economy. Developing countries face a lot of problems associated with urbanisation and need immediate attention. Fuwape and Onyekwelu (2011) wrote that “urbanisation puts pressure on land, scarce natural resources, infrastructure and the environment, which could lead to social tensions among different interest

groups, others are: shortage of land, provision of food, energy and wood for construction". Additionally, increased unemployment rates where urbanisation is higher than job creation, results in crime and violence as a means of survival (Baker, 2008). Globally, Poverty is rampant with 43% and 22 % of the population living in poverty if the US\$2 per day and US\$1 per day poverty lines are considered, respectively (World Bank, 2012). There are however differences between countries and within countries. Africa, being one of the rapidly urbanising regions, has 40% and 70% of its urban residents being poor when the US\$1 and US\$2 per day poverty lines are considered, respectively (Baker, 2008; Ravallion *et al.*, 2007). According to Woolard (2002), between eight and 18 million South Africans, out of a total population of 44 million in 2000, were living below the poverty line. In addition, over a quarter (30%) of South Africans living in urban areas are poor (May *et al.*, 2000). Poor individuals or households fail to meet essential basic needs such as food, clothing and shelter (Woolard and Leibbrandt, 1999). In addition, the proportion of poor people rose from 34.3% in 2000 and reached 40.5% in 2005 (Frye, 2006). Consequently, due to the high number of people migrating into urban areas, poverty is also shifting from being a rural phenomenon to being an urban one (Baker, 2008; Kuchelmeister, 2000).

Whilst urbanisation is associated with these challenges, it may have positive effects on the economy of households and the nation. Migration of people from rural areas to urban areas can be seen as a livelihood strategy which allows them to improve their livelihoods and well-being (Lehohla, 2006; Meikle *et al.*, 2001). For example, migration is a job hunting strategy (Lehohla, 2006). Hence, migration is a way out of unemployment and other hardships associated with rural life. Lehohla (2006) argued that rural-urban migration does not cause unemployment, unless if employed rural individuals leave their jobs and stay in urban areas without employment. Instead, migration of rural households to urban areas is important to their livelihood improvement (de Haan, 2000). Migrants improve their access to employment (informal or formal), food, health, education, sanitation and many other social amenities provided in urban areas which are not available or of poor quality in rural areas. Migration therefore offers opportunities to households and individuals that can improve their future livelihoods and well-being (Lehohla, 2006). When individuals migrate to urban areas, they remit monetary and non-monetary assistance to their families in rural areas. It was reported that rural households with family members in urban areas have higher capital (livestock) than those with fewer or no relatives in towns and cities (Collinson *et al.*, 2005). Migration of low-skilled and uneducated rural individuals offers cheap labour to mines, and industries and provides drivers, security guards, domestic workers and many more (Lehohla, 2006). In addition, migration may bring young and new entrepreneurs with good qualities contributing to the urban economic growth (Lehohla, 2006). These entrepreneurs may also create employment for other local people.

1.3 Natural resource use, poverty alleviation and rural livelihoods

Natural resources are known to support rural livelihoods in developing countries. They are not only limited to rural livelihoods; they also provide benefits to the national economy as well as the environment (Rigg, 2006). Natural lands are sources of a wide range of products derived from both fauna and flora. They encompass fruits, herbal medicines, fuelwood, wood for building and fencing (Twine *et al.*, 2003). Others are bark, seeds, flowers, grass, resins, fibres, rattan, mushrooms, honey, insects, caterpillars and game (Rigg, 2006). Rural households in developing countries collect these products for direct consumption as well as for sale to generate cash income. Collection of natural resources takes two forms; some households may collect them for use on a daily basis fulfilling the role of daily needs (Shackleton and Shackleton, 2004). Households can collect natural resources throughout the year depending on availability of the products. They may make trips solely to collect them or collect them on their way back from their fields or combine with other activities (Delang, 2006). At other times, natural resources are collected for use or sale as a safety net during crisis (Mulenga *et al.*, 2012; Paumgarten and Shackleton, 2011). These periods include off seasons, times of sickness, death and crop failure. In such times of crises, households may resort to collection of natural resources to lessen the impact; hence it is viewed as a coping strategy (Paumgarten and Shackleton, 2011). Thus, natural resources reduce the effects of shocks and stresses affecting the survival of households.

Food shortages in rural areas can be widespread; households can experience shortages for about six to nine months each year (Bista and Webb, 2006; Kalaba *et al.*, 2009; Rigg, 2006). Consequently, households switch to collection of food from the wild during these months (Bista and Webb, 2006). In order to survive during these periods of deficits, households employ many coping strategies (Paumgarten and Shackleton, 2011). They include offering labour, selling assets, use and sale of natural resources (Rigg, 2006). Households which fail to produce sufficient food from their cultivated lands, collect natural resources to reduce their vulnerability in difficult times. Hence, natural resources play an important role of safety net during years of crop failure (Mulenga *et al.*, 2012; Paumgarten and Shackleton, 2011).

Studies have shown that the majority of rural households depend on natural resources. Between 48.8% and 100% of households in South African rural areas collect various kinds of natural products (Shackleton and Shackleton, 2004). Similarly, almost every rural household (97%) in Zambia depends on natural resources (Kalaba *et al.*, 2009). They do not just collect one kind of product; however they combine a wide range of products. In Limpopo Province, between 200 and 300 different plant species are used for numerous purposes (Shackleton and Shackleton, 2004). Like any developing country, a total of 134 wild food plants are collected from forests in Thailand of which 28.4% are from trees (Delang, 2006). In Nepal, each rural household collects at least one natural resource (Bista and Webb,

2006). This shows how essential natural resources can be to rural livelihoods and that a diversity of them are utilised.

Poor households do not just depend on one livelihood activity; they employ a number of livelihood activities and have a wide range of sources of income which includes both formal and informal sources (Davenport *et al.*, 2012; Kalaba *et al.*, 2009). According to Campbell and Luckert (2002) “a household can be involved in livestock-keeping; growing a diversity of crops; collecting forest products for subsistence needs and sales; having one family member in off-farm employment who remits money back to the household and having another member involved in some small-scale industry (e.g. brick-burning, carpentry, wood carving, beer brewing)”. Paumgarten and Shackleton (2011) also listed a lot of coping strategies that are used by rural households, which include natural resource use.

Poorer households are more reliant on natural resources than their rich counterparts (Mulenga *et al.* 2012). Therefore, it is poverty stricken households which make use of natural resources most of the time (Paumgarten and Shackleton, 2011). Campbell and Luckert (2002) predicted that the poorest people depend very much on forests and forest products. However, it was disputed by USAID (2006) and Adhikari (2005) that both the rich and poor use natural resources. The paper further elaborates that natural resources are used in different ways. In cases where there is large capital investment, the rich people are the ones who harvest the resources and vice versa (Campbell and Luckert, 2002). Thus, poorer households generally produce small carpentry items, while more wealthy households make large items (Cavendish, 1997). This is an indication that both the rich as well as the poor households make use of natural resources, however on different scales (Shackleton and Shackleton, 2006).

When rural households or individuals migrate to urban areas, they may continue to collect natural resources from landscapes or trees within urban areas, on the edges of towns or even beyond edges of towns. This potentially makes the trees within their reach very important to their day to day subsistence or during times of crises. This is because rural households have low capital such as finance and skills, and are more vulnerable to shocks and stresses (Browder, 1992; Padoch, 1992). Hence, when such households or individuals migrate to urban areas, they shift with such characteristics as mentioned above. According to van Averbeke (2007) 88% of residents in informal residential areas in South Africa are new and their origins are rural. Furthermore, recent urban migrants continue their rural way of life like collecting natural resources to earn a living (Cocks and Dold, 2006). Thus, given the high urbanisation and unemployment levels, many new urban people can be expected to depend on urban trees.

1.4 Benefits of urban forests

The benefits of forests and trees to the natural environment and rural communities are well known globally, including in South Africa (Delang, 2006; Kalaba *et al.*, 2009; Legwaila *et al.*, 2011). The benefits derived from urban forests in both public and private spaces are the same as the ones obtained from natural forests (Kuchelmeister, 2000; Shackleton, 2006; Fuwape and Onyekwelu, 2011). The ability of urban forests and trees to sustain livelihoods of the people in urban areas has been noted (Fuwape and Onyekwelu, 2011; Horst, 2006; Kuchelmeister, 2000). Urban forest resources can play active roles in providing services to alleviate poverty, improve livelihoods, and enhance the well-being of people (Fuwape and Onyekwelu, 2011). Recent studies in developing countries have shown that urban forests and trees offer provisioning, cultural and supporting services just like conventional forests (Fuwape and Onyekwelu, 2011; Kuchelmeister, 2000; Shackleton, 2006). According to Bentsen *et al.* (2010) and Fuwape and Onyekwelu (2011) examples of urban forests include: private spaces which are made up of trees on residential and industrial properties; public green spaces like parks, street trees, roadside plantations and woodlots, botanical gardens and recreational gardens; public and private tree plantations on vacant lots, green belts, woodlands and peri-urban tree plantations; rangeland and forests close to urban areas. Urban forestry is one of the promising approaches which can help reduce some of the multiple problems of urbanisation. “Urban forestry is an integrated approach to the planting, care and management of trees in urban and peri-urban areas to secure economic, environmental and social benefits for urban residents; it also includes trees in private gardens and the management of natural forests or woodlands within the urban or edges of towns” (NFAP, 1997). One of the challenges faced with urban forestry is to determine the demarcation where urban forests end and where rural forests start (Shackleton, 2006). In this study, trees within the towns as well as those immediately after the edges of towns are considered to be urban forests. However, in some reports trees on the edges of towns are not considered to be part of urban forests (Malimbwi *et al.*, 2010; Openshaw, 2010).

The multiple goods and services that urban trees and forests provide can be divided into consumptive products (provisioning services) such as fuelwood, fruits (Fuwape and Onyekwelu, 2011; Horst, 2006; Kuchelmeister, 2001), wood for building and fencing, fodder, medicines (Fuwape and Onyekwelu, 2011; Kuchelmeister, 2000; Uddin, 2006) and non-consumptive products (cultural and supporting services) such as habitat protection, watershed and soil protection, carbon sequestration, noise and air pollution reduction, beauty, shade, recreation, educational, scientific, spiritual and religious significance (Horst, 2006; MEA, 2005; Shackleton, 2006). Consumptive tree products from urban forests support the livelihoods of poor households in urban areas. They can be used on a daily basis or during difficult times (Fuwape and Onyekwelu, 2011; McConnachie *et al.*, 2008; Murwendo, 2011), sold to generate income (Murwendo, 2011; Shackleton, 2006) or saving money by not buying the tree

products which can be collected freely (Delang, 2006; Murwendo, 2011). There is increasing poverty levels in South Africa (Frye, 2006), coupled with high urbanisation rates (Lehohla, 2006) and the likelihood of increasing unemployment levels. Hence, the use and sale of tree products together with other natural resources obtained from forests will continue, especially as their exploitation does not require high skills or capital investment (Campbell and Luckert, 2002; Paumgarten and Shackleton, 2011).

1.5 Supply of tree products

Not all tree products consumed by urban households are sourced within urban areas; there are some products that are brought into urban areas from outside. The supply of externally sourced tree products consists of several activities, among them collection, processing and transportation (Kaplinsky and Morris, 2002; Openshaw, 2010). These activities involve various players such as collectors (producers), middlemen and traders who embark on several activities (Mikolo, 2007; Openshaw, 2010). The trade in tree products is often exploitative on the side of producers as they generate a lower income share than middlemen and retail traders. They do not set the prices of goods which are determined by middlemen and retailers (Mikolo, 2007; Shackleton and Shackleton, 2003; 2004). In regard to transportation, there are many modes of transport that are used by harvesters and traders of tree products. In Malawi, the majority use manual means such as bicycles and head-loading, although motorised transport is also used e.g. vans (Openshaw, 2010). Kalaba *et al.* (2009) and Paumgarten and Shackleton (2011) show gender and age differentiation in collecting tree products; this is segmented into male or female and children dominated activities. Women and children, who are the most vulnerable groups (Chidumayo and Marunda, 2010), do not take part in labour intensive activities such as charcoal production, carpentry or wood carving. However, they dominate fuelwood and fruit collection activities (Dovie *et al.*, 2004; Kalaba *et al.*, 2009; Mougeot, 1999). In addition, they are also active in the brush industry, beer brewing and weaving activities (CSG, 1998; Shackleton and Shackleton, 2003; 2004). On the contrary, collection of herbal medicines equally involves both men and women (Cocks and Dold, 2005).

Harvesters and traders of tree products frequently have low or little capital, are more vulnerable to shocks, and are poor and less educated (Campbell and Luckert, 2002; Shackleton and Shackleton, 2003; WOW, 2007). Shocks and stresses are events or factors that affect the livelihoods of people abruptly or gradually for a period of time. Consequently, they reduce the capital base of poor households (Ellis and Allison, 2004). Examples include unsteady economies, Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS), civil unrest, biodiversity loss, climate change, deaths, crop failure and natural disasters. If more educated people get into natural resource trade, they typically make more profit than less educated competitors (Nkuna, 2004). They have the ability to negotiate for better prices than those who have low education

levels (Mikolo, 2007). Davenport *et al.* (2011) found that households which collect tree products from urban commonages had household heads with lower education than those which do not collect tree products. The more educated individuals and households do not rely so much on natural resources compared to less educated people, simply because they can compete for better paying jobs.

1.6 Factors affecting trees and tree products

The reduction in numbers of trees in towns and around towns is a common phenomenon (SNR, 2005), due to development and high collection of fuelwood for energy (Kalaba *et al.*, 2009). As more people migrate into urban areas, the demand for tree products is expected to increase (Malimbwi *et al.*, 2010; UNEP, 2002), potentially resulting in overexploitation and depletion of tree resources (Malimbwi *et al.*, 2010). According to Steenkamp (1999) resource degradation is due to transforming forest land into farms, collection of fuelwood, production of charcoal, collecting wood for building and many other destructive usages. Given the high number of people moving into urban areas, more land is converted into residential areas (Openshaw, 2010) and many trees are cut down to build houses (Padoch *et al.*, 2008). Other factors affecting trees and tree products include: seasonality (Kalaba *et al.*, 2009; Matose, 2006; Mikolo, 2007), seasonal products include fruits while perennial products include fuelwood, fodder, wood for building and fibre (Kalaba *et al.*, 2009); access to resources (Matose, 2006; Mikolo, 2007); scarcity of trees and tree products (CIFOR, 2002; Kalaba *et al.*, 2009; Mikolo, 2007); environmental conditions e.g. weather (CSG, 1998); and abiotic conditions, such as urban pollution and soil quality (Kuruneri-Chitepo and Shackleton, 2011; Uddin and Husan, 2001), fires, pests and diseases and antagonistic interests between people (Konijnendijk *et al.*, 2004). All these factors result in reduced forest cover, which in turn leads to a reduction in the abundance and diversity of trees. Collectors may embark on long walks to collect the products, therefore increasing the opportunity costs and livelihood vulnerability (Kalaba *et al.*, 2009).

1.7 Urban residential areas

Towns in South Africa and elsewhere are not homogenous; they are stratified into different residential areas. For much of the twentieth century in South Africa, this stratification was determined by race. The apartheid government restricted South African black people in urban areas. They created homelands for them and the limited numbers of blacks who managed to get permits to live in urban areas, had to live in racially defined residential areas, with each race having its own distinct residential area. The residential areas for blacks were called townships (Wilkinson, 1998), which were characterised by poor planning and service delivery, backyard shacks, low commercial activities, high poverty levels and high population density. In contrast, residential areas for whites were well planned, with good service delivery, nice infrastructure, public green spaces and low population densities (McConnachie and Shackleton, 2010). With the ANC coming into power in the 1990s, it wanted to

address the various injustices experienced by the majority of black South Africans. The aim of the new government was to empower the previously disadvantaged citizens. The current government also lifted the ban on movement of black South Africans. It introduced the Reconstruction and Development Programme (RDP), a programme with the aim of building houses for the poor for free and the houses built in this programme are called RDP houses. The benefit of the RDP lies in the provision of decent accommodation to poor households who cannot afford to buy land and build good quality housing. Given that, for many decades the majority South Africans have been marginalised for many years. Any formal housing can be viewed as a source of capital, according to Rust (2008) housing acts as a source of social and financial capital. Hence, the above forms of capital can be seen as the benefits of the establishment of RDP houses. Socially, housing promotes identity and security, helps households build social networks and have access to social amenities and services (Social Housing Foundation, 2009). Financially, housing helps to save income to be spent on house rentals. In addition, housing can help households generate income through renting out accommodation and can be used as collateral (Social Housing Foundatio, 2009). However, due to the high inflows of people into towns and cities many people still remain without decent shelter and remain on the waiting lists. Thus, many new urban migrants established informal residential areas whilst waiting for housing. This trend can be viewed as a disadvantage of providing housing in this programme which leads to the challenges of urbanisation as earlier alluded to in this chapter. Informal residential areas are formed mostly because of land invasions. According to Landman and Napier (2010) municipalities may upgrade the informal residential area with the provision of infrastructure and services. This however depends on many factors such as land location, suitability and ownership. Therefore, there are four types of residential areas which can be identified in most South African towns, namely affluent, township, RDP and informal residential areas. Formal urban residential areas are structured, organised, and have permanent houses (townships, RDP and affluent residential areas) while informal residential areas (slums or squatter camps) are established on land which is not surveyed or zoned for urban housing (Stats SA, 2001), the structures are of poor quality and not durable (UN-Habitat, 2003). According to UN-Habitat (2010), in sub-Saharan Africa, 61.7% of the urban population live in informal residential areas. This means that the role of urban forests is not equal and the presence and use of trees and tree products will potentially differ markedly from one residential area to another. Photographs of the three types of residential areas in South Africa are given figure 1.1.




Informal	RDP	Township
		
Sources: Travelling (2013)	Centre for Environmental Structure (2006)	Guardian (2010)

Figure 1.1: Photographs of the three types of residential areas in South Africa

1.8 Household and urban forest characteristics

The size of homestead plots in different residential areas varies tremendously. Homestead plots in the RDP areas are the smallest (15 times less than affluent suburbs), then township and the affluent suburbs are the largest among formal residential areas (McConnachie and Shackleton, 2010). Plot sizes in the informal residential areas differ markedly (Lizarralde and Massyn, 2008), ranging from 100 m² to 400 m² (van Averbek, 2007). Because of the smaller plot size, it is expected that RDP residential areas would have fewer trees on the home plots compared to other formal residential areas. Considering other forms of urban forests, for example street trees, the township and RDP residential areas have very few trees compared to the number of street trees in affluent residential areas (Kuruneri-Chitepo and Shackleton, 2011). The other characteristic of trees in urban areas is that trees in residential areas for the RDP and township residential area are usually smaller than the ones in affluent residential areas (Stoffberg *et al.*, 2010). In terms of other public green spaces, poor residential areas also have very few such green spaces (McConnachie *et al.*, 2008; McConnachie and Shackleton, 2010) and most are dominated by alien tree species. Kuruneri-Chitepo and Shackleton (2011) reported that street trees were made up of higher proportions (56%) of alien trees; likewise McConnachie *et al.* (2008) reported a higher proportion (59.9%) of alien trees in public green spaces in South Africa. This is contrary to trends in developed countries (Pysek, 1998; Clement and Moore, 2003; Frank *et al.*, 2006).

Households in the informal residential areas typically have a large number of persons per household (van Averbek, 2007) followed by those in the RDP area and township and the least being affluent households (McConnachie and Shackleton, 2010). The RDP and township households are poorer than the affluent households and experience much higher unemployment rates than affluent residential areas (McConnachie and Shackleton, 2010). Worse unemployment levels are experienced in informal residential areas, typically over half (58-72%) of residents are without employment (Richards *et al.*, 2007). Income levels and population density correlate with the mean public green space species richness (McConnachie *et al.*, 2008).

Informal residential areas have poor water supply and sanitation, are overcrowded and houses are of poor quality (UN-Habitat, 2003). Due to the fact that they are not formal and all characteristics about them are poor, it is expected that the households in informal residential areas would be economically worse off than RDP and township residential areas. Consequently, they are anticipated to have a much higher dependence on trees and tree products since poorer households are the ones which are more dependent on tree products (Davenport *et al.*, 2011; Shackleton *et al.*, 2007).

1.9 Research gap

Although urban trees and forests offer numerous benefits, their contribution to urban livelihoods has not been comprehensively documented (Raoufou *et al.*, 2011; Shackleton, 2006; Uddin, 2006). There are few studies that have been conducted in Africa and the little that has been done comes from South Africa, Togo, Uganda, Ethiopia and some parts of West Africa. This is due to the fact that urban forestry and urban greening is perceived as an emerging issue (Bentsen *et al.*, 2010) and is considered as a young science in developing countries (Kuchelmeister, 1999). Consequently, many countries, global policy processes and international forestry research agencies have not identified urban forestry as a subject; their exclusive focus is on conventional forestry. Some exceptions include Senegal, South Africa and Sierra Leone which have recognised urban forestry in their national forestry programmes (Kuchelmeister, 1999). Most of the research work is based on examples from Europe and America which has focused so much on non-consumptive benefits (cultural and supporting services) rather than consumptive benefits (Shackleton, 2012). The recreational and aesthetic benefits are the most important benefits perceived in the Nordic countries, whereas protective and climatic benefits are appreciated more in other parts of the world (Konijnendijk *et al.*, 2004). The consumptive benefits (provisioning services) of trees are often overlooked in urban areas.

The contribution of urban trees and tree products to livelihoods in South Africa is poorly known, and as yet rarely disaggregated by residency or household characteristics. Given accelerated urbanisation levels in South Africa, new urban migrants are expected to depend on urban forests to supplement their livelihoods. Consequently, it is necessary to determine the magnitude and nature of the contribution of trees and consumptive tree products to urban households.

1.10 Objective

The main objective of this study was to determine the magnitude and nature of the direct contribution of trees and tree products to local livelihoods in different urban residential areas. This objective was encapsulated in the following key research questions:

- What is the abundance, distribution, richness and attributes of homestead trees in different urban residential areas?
- What are the tree products that urban households collect and use from trees on homesteads, other places and buy from traders?
- What is the direct-use value of tree products used by urban communities?

2 Study area

This study was conducted in three South African towns in Limpopo and North West provinces (Figure 1.1). Both physically and demographically, Limpopo Province has both a larger area (123 910 km² vs.

116 320 km²) and population (5 273 642 vs. 3 669 349) than North West province (Stats SA, 2003). Both provinces have a high black African population followed by whites, coloureds and lastly Asians (Stats SA, 2003). The most dominant ethnic groups in Limpopo Province are the Sepedi (52%) and Xitsonga (22%) speaking people, whereas in North West province, Setswana (65%) and Afrikaans (8%) speaking people make up the major groups (Stats SA, 2003). This shows that different study towns are occupied by different dominant ethnic groups. Limpopo Province has a higher proportion (33%) of people aged 20 years and older without any formal education than North West province (20%) (Stats SA, 2003). Approximately 6-7% of the population in both provinces has reached tertiary education (Stats SA, 2003). In regard to housing status, Limpopo Province has a higher proportion of formal housing (83.2%) than North West province (66.5%) with the latter experiencing decreasing proportions, the opposite is true for informal residential areas with North West recording 23.8% than Limpopo Province's 5.6% (Stats SA, 2003; 2008). In addition, Limpopo Province has the lowest urbanisation rates estimated at 10 % whereas North West has 41% (Lehohla, 2006).

The three study towns were Tzaneen, Bela Bela and Zeerust (Figure 1.1) and the local municipalities in these towns are the Greater Tzaneen, Bela Bela and Ramotshere Moiloa, respectively. The selected towns in these provinces span a linear gradient of relatively high rainfall to low rainfall; Tzaneen receives the highest rainfall (775 mm p.a.), followed by Bela Bela (650 mm p.a.) and Zeerust (575 mm p.a.) as the driest town (Mucina *et al.*, 2005). All towns are found in the savanna biome; Tzaneen is in the Lowveld Bioregion while Bela Bela and Zeerust are in the Central Bushveld Bioregion. Within each study town, sampling was conducted in three residential areas, namely (i) township, (ii) RDP and (iii) informal residential areas.

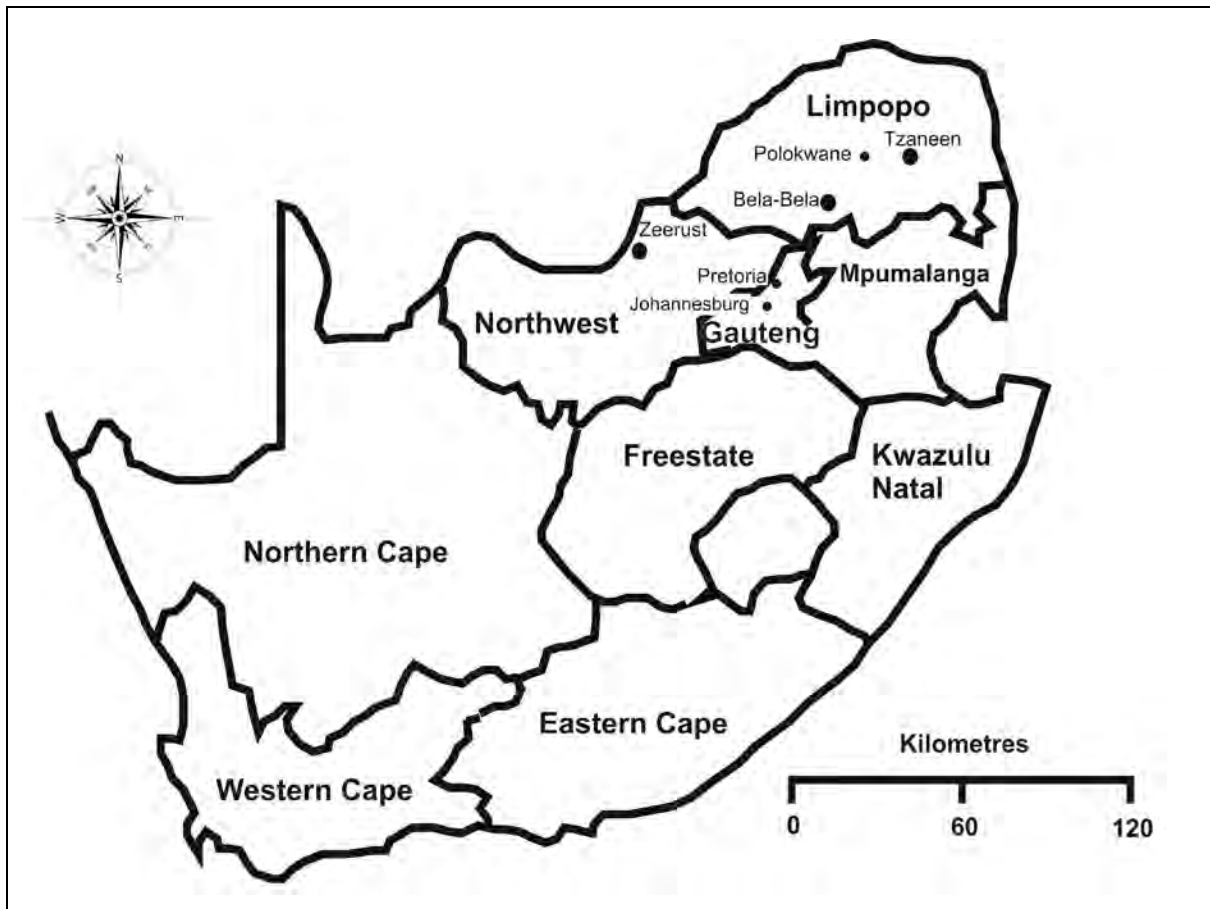


Figure 1.2: The three study towns (Tzaneen, Bela Bela and Zeerust) in South Africa

2.1 Tzaneen

Tzaneen (23° 50' S 30° 10' E) is located at an altitudinal range of 600 m to 1 000 m above sea level in Limpopo Province (Figure 1.1). Reputedly Tzaneen is derived from the word ‘Tsaneng’, meaning come together (Greater Tzaneen Local Municipality IDP, 2011). Tzaneen has many ethnic groups and a diversity of cultures. History has that in 1919 the area was surveyed, planned and a certificate of township (not in the sense of residential area) was issued for Tzaneen and it became a town (Greater Tzaneen Local Municipality IDP, 2011). This town falls in the Greater Tzaneen Local municipality, situated in Mopani District Municipality. The Greater Tzaneen Local Municipality is estimated to be 3 240 km² and stretches from Haenertsburg in the west, to Rubbervale in the east, and from Modjadjiskloof in the north, to Trichardtsdal in the south (Greater Tzaneen Local Municipality IDP, 2011). The Greater Tzaneen Local Municipality area consists of Tzaneen, Nkowankowa, Lenyenye, Letsitele and Haenertsburg. The study was specifically conducted in Nkowankowa, RDP and Lusaka (informal) residential areas.

2.1.1 Population size

The population for Greater Tzaneen Local Municipality in the 2001 census was reported to be 375 586. However, the Community Survey in 2007 reported a figure of 349 087, nevertheless the number of households in this locality stood at 85 993 households in 2001 and rose to 89 831 in 2007 (Stats SA, 2008). Among the three study towns this town has the highest population. The population is dominated by children and youths, which makes up 74%, while the remainder comprises those who are older than 35 years. The proportion of females is approximately 54.4% (Greater Tzaneen Local Municipality IDP, 2011). Even though there are more females than males, more households (53.4%) are headed by males (Greater Tzaneen Local Municipality IDP, 2011). The majority of the people in local municipality live in rural areas. According to Greater Tzaneen Local Municipality IDP (2011), only 20% live in urban areas.

2.1.2 Housing status

This local municipality has the highest number of households in formal residential areas and fewer informal residential areas than the two sampled towns. The proportion of households in formal residential areas in Greater Tzaneen Local Municipality increased from 68.8% in 2001 to 86.6% in 2007, accompanied by a decrease in the proportion of households in the informal residential area from 4% in 2001 to 2.9% in 2007 (Stats SA, 2008). This can be attributed to the government's policy on providing shelter through the construction of RDP houses which are freely given to the local disadvantaged people. This is an indicator of wealth and well-being, it can therefore be stated that residents in this area are wealthier than residents in the other local municipalities.

2.1.3 Economic status

The percentage of households without any source of recorded cash income stands at 29%, whilst 17% earn less than R4 800 per month. The income levels for most of the households (70%) are below the minimum level of R9 600 per annum (Stats SA, 2008). The employment status is characterised by 20% unemployed, 28% employed and 49% not economically active (Stats SA, 2008). The main sectors that offer employment are agriculture and manufacturing. Agriculture is the main economic driver for the municipality contributing 43% to the district GDP and 40% employment. The most common commercial crops are tropical and citrus fruits. The second most important sector is manufacturing which contributes 38% of district GDP (Greater Tzaneen Local Municipality IDP, 2011).

2.1.4 Literacy levels

Literacy levels in South Africa are low especially for black South Africans who were previously hindered from attending higher education by the previous Apartheid government. Very few education institutions existed in residential areas for blacks and for those who managed to complete secondary education mostly were only allowed to pursue certificate and diploma education and not beyond. Uneducated people in this municipality stands at 36.7% in this local municipality and only 14.4% of the people have reached Grade 12 level and just 10.4% of the population have reached postgraduate level (Stats SA, 2008).

2.1.5 Vegetation and climate

The topography in the western and southern parts of this municipality is mountainous and inaccessible, whilst the terrain in the north and east is uneven and characterised by gentle slopes. This gives the area a natural beauty and acts as a tourist attraction. The vegetation type in this region is the Tzaneen Sour Bushveld which forms part of the lowveld Bioregion (Mucina *et al.*, 2005). The main tall trees are *Pterocarpus angolensis* and *Sclerocarya birrea* subsp. *caffra* (Mucina *et al.*, 2005). Whereas small trees include *Acacia polyacantha*, *Albizia versicolor*, *Ficus sansibarica*, *Parinari curatellifolia*, *Piliostigma thonningii*, *Pterocarpus rotundifolius*, *Trichilia emetica*, *Acacia devyi*, *A. sieberiana* var *woodii*, *Antidesma venosum*, *Catha edulis*, *Faurea rochetiana*, *F. saligna* and many more (Mucina *et al.*, 2005).

The geology consists of the potassium poor gneisses of the Goudplaatsgneiss and the Archaean granite dyke, there are also few shales and quartzite rocks in the region (Mucina *et al.*, 2005). The soil types in this town are “Mispah, Glenrosa, shallow to deep sandy and gravelly and well drained” (Mucina *et al.*, 2005).

This town has wet summers and warm winters with annual rainfall ranging between 550 and 1 000 mm per annum; most of the rain is received in mid-summer with dry winters (Mucina *et al.*, 2005). Low lying areas experience frequent frost while the higher land experiences frost less frequently. The mean monthly maximum temperatures of 36.4 °C is experienced in January and minimum of 3.9 °C in June (Mucina *et al.*, 2005).

2.2 Bela Bela

Bela Bela is also found in Limpopo Province and is situated at 24° 54' S 28° 20' E at an altitude ranging between 900 and 1 200 m above sea level (Figure 1.1). The former name for Bela Bela was Warmbaths. Bela Bela is a Tswana word which means ‘boiling pot’. This name was given to this town because of the hot water springs in the town. Somewhere around 1870, the then Transvaal

Government bought the land and built a resort to support the town. Its name then was Hartingsburg which ended in 1905 when it was named Warmbaths by the British government. It only became a town in 1960 when it achieved a town council status. This marked the start of development in this area which saw establishment of new residential areas, businesses, schools and hotels. In 2002, the new government changed the name to Bela Bela. The Tswana ethnic group were the first people to settle in the land around 1800, however at the moment it has many ethnic groups such as the Sothos. The local municipality is Bela Bela local municipality which belongs to the Waterberg District Municipality. The area of this municipality is 3 376 km² with 70.2% remaining more or less natural under extensive grazing system.

2.2.1 Population size

The population for Bela Bela showed an increase from 52 124 individuals in 2001 to 55 844 individuals in 2007 which was attributed to natural population growth and migration (Bela Bela Local Municipality IDP, 2010). Likewise, the number of households increased from 12 335 in 2001 to 14 290 (Stats SA, 2008). This is the smallest town in this study. Similar to Tzaneen, the population for Bela Bela is mainly composed of children younger than 14 years (33%) and youths (35%). Adults between the age of 35 and 64 make up 25% and the remainder is taken up of adults older than 64 years old. The gender composition in Bela Bela Local Municipality, according to Stats SA (2008), has a slight higher number (51%) of females than males.

2.2.2 Housing status

Contrary to the trends in Greater Tzaneen and Ramotshere Moiloa Local Municipality, the proportion of formal households decreased between the 2001 and 2007. This local municipality has the lowest proportion of households in formal residential areas; however it has the highest percentage of informal residential areas. Households in formal residential areas decreased from 79.3% in 2001 to 74.4% in 2007 with an increase in the proportion of households in the informal residential area from 16.5% to 22.3% (Stats SA, 2008). Given the increase in the number of households in the informal residential area, this municipality is likely to have high urbanisation rates and the number of poor people is also larger than the other two municipalities.

2.2.3 Economic status

The labour force excludes children and those who are older than 64 years old, hence the labour force is made up of the age group of 18 to 64 years which includes 23 722 individuals. 31% of the labour force is unemployed. About 11% (1 534) households receive less than R 1 100 per month and these households are classified as poor and they are mainly black South Africans (Bela Bela Local Municipality IDP, 2010). Consequently, these households are likely to depend on government grants

to supplement their income. The economy of Bela Bela is based mainly on the tourism sector (34%), construction (21%) and agriculture (15%) (Bela Bela Local Municipality IDP, 2010). These sectors are important as they offer the local people with employment even though some sectors are characterised by poor working conditions and low wages. Bela Bela has a growing tourism potential due to the attractive natural environment (Bela Bela Local Municipality IDP, 2010). The area boasts natural hot springs, with significant private investment in tourism facilities and hospitality enterprises. Being near Gauteng province, approximately 170 km from Johannesburg, makes Bela Bela an alternative tourist destination (Bela Bela Local Municipality IDP, 2010).

2.2.4 Literacy levels

The South African government attaches great importance to education and its constitution clearly stipulates that it is a fundamental human right. However, the proportion of illiterate individuals in this area is high. About 16% of the people in this local municipality have never been to school. Approximately 17% of the people have completed secondary school education and very few people (7%) have reached higher education. According to Bela Bela Local Municipality IDP (2010), contributing factors include lack of financial resources for individuals to pursue secondary and higher education; in addition the lack of education facilities for tertiary education has also worsened the education situation.

2.2.5 Vegetation and climate

The topography is relatively flat on the west and south, however, it is mountainous on the eastern and northern parts. The vegetation type in this region is the Springbokvlakte Thornveld which forms part of the Central Bushveld Bioregion (Mucina *et al.*, 2005). This vegetation type is also found in Zeerust with tree species such as *Acacia karroo*, *A. luederitzii* var *retinens*, *A. mellifera*, *A. nilotica*, *Ziziphus mucronata*, and *Boscia foetida* subsp. *rehmanniana* as small trees. Tall shrubs include *Euclea undulata*, *Searsia engleri*, *Dichorstachys cinerea*, *Diospyros lycioides* subsp. *lycioides*, *Grewia flava* and *Tarchonantus camphoratus*, whereas low shrubs include *Acacia tenuspina* and *Ptychlobium plicatum* (Mucina *et al.*, 2005).

According to Mucina *et al.* (2005) the geology has rocks made of Karoo super group volcano-sediments. The most common ones are the mafic volcanic rocks, mudstones and shale. The characteristics of the soils in this region are “red-yellow apedal, freely drained with high base status and self-mulching, black, vertic clays” (Mucina *et al.*, 2005). The principal characteristic of vertic clay soils is that they expand during summer (November to March) and contract during the dry season resulting in soil cracks (Mucina *et al.*, 2005).

The area receives summer rainfall ranging between 500 and 650 mm per annum with generally dry winters, though there is an experience of frost in this season (Mucina *et al.*, 2005). The average monthly maximum temperature is 35.2 °C strangely in October and the minimum temperature in July is -2 °C (Mucina *et al.*, 2005). Bela Bela is the coldest town among the three study towns.

2.3 Zeerust

Zeerust (25° 32' S 26° 6' E) is found in North West province at an altitude varying between 1 000 and 1 200 m above sea level (Figure 1.1). This town, just like Bela Bela, started as a farm, in 1858 and its name was Sefathlane (dusty place) by Casper Hendrik Coetzee. He wanted to build a town and church on his farm; however he died before it was built. In 1867, it became a town named after the farm owner Coetzee-Rust (Coetzee's Rest) which was later shortened to Zeerust. It achieved a Municipal status in 1936 until 1994 when it was changed. The two main languages spoken in this town are Setswana and Afrikaans. The local municipality is the Ramotshere Moiloa Local Municipality which is located in the Central district municipality and the area of this municipality is approximately 7 193 km² (Ngaka Modiri Molema District Municipality IDP, 2007; Stats SA, 2008).

2.3.1 Population size

The population for Ramotshere Moiloa Local Municipality decreased from 137 443 individuals in 2001 to 129 304 individuals in 2007. Similarly, the number of households decreased from 31 988 in 2001 to 30 302 in 2007 (Stats SA, 2008). This is the second largest study town. There is a higher percentage of females (53%) than males at 47% (Ngaka Modiri Molema District Municipality IDP, 2007; Stats SA, 2008).

2.3.2 Housing status

The classification of households in this local municipality indicates that 86.4% are formal and 9.7% are informal (Stats SA, 2008). The percentage of formal households in Zeerust increased from 81.3% in 2001 to 86.4% in 2007, while households in the informal residential areas slightly increased from 9.2% in 2001 to 9.7% in 2007 (Stats SA, 2008). The increase in informal households is accounted for by the non-construction of RDP houses as the last ones were built more than ten years ago. The formal residential areas encompass affluent suburbs, older townships and RDP houses. Approximately 42% of the population lives in three room houses (Ngaka Modiri Molema District Municipality IDP, 2007). In term of housing status, this municipality lies in between Greater Tzaneen and Bela Bela Local Municipalities.

2.3.3 Economic status

Most households (78%) in Ramotshere Moiloa Local Municipality have low income (R1 500 or less per month). Consequently, approximately 55-80% of the population live in poverty (Ngaka Modiri Molema District Municipality IDP, 2007; Stats SA, 2008). Regarding employment, the municipality in Zeerust has the second highest unemployment percentage in the Central district municipality, which is estimated at 54%. Given the high percentage of people with low monthly income and high unemployment rates, many households depend on wood for heating purposes (Ngaka Modiri Molema District Municipality IDP, 2007) and are likely to be sustained by government grants. The major employer in Zeerust is the government which accounts for 37.1%, followed by wholesale and retail industry (13.1%), while the agriculture, forestry and fisheries accounts for 6.4% and the mining industry accounts for 2.2% (Ngaka Modiri Molema District Municipality IDP, 2007).

2.3.4 Literacy levels

Approximately 34.7% of the people in this local municipality have no formal education (Ngaka Modiri Molema District Municipality IDP, 2007). Only 15.7% have completed secondary school education and 5% have reached higher education. This shows that a lot of people have very low skill levels and are likely to have low paying jobs. Therefore, a lot of people live in poverty because some studies have revealed that poverty and education are positively correlated (Woolard and Leibbrandt, 1999).

2.3.5 Vegetation and climate

The topography in this area is 47% mountainous and is characterised by thickets with limited pockets of woodlands (Ngaka Modiri Molema District Municipality IDP, 2007). The vegetation type is the Zeerust Thornveld which is part of the Central Bushveld Bioregion (Mucina *et al.*, 2005). Tall trees in this vegetation type embrace *Acacia burkei* and *A. erioloba* while small trees include *Acacia mellifera* subsp. *detinens*, *A. nilotica*, *A. tortilis* subsp. *heteracantha*, *Searsia lancea*, *Acacia fleckii*, *Peltophorum africanum* and *Terminalia sericea* (Mucina *et al.*, 2005).

The geology in this area is made up of the Pretoria Group sediments, with Silverton and Rayton rocks composed of mainly shale and little amounts of quartzite and conglomerate (Mucina *et al.*, 2005). Soil characteristics include deep, red-yellow, apedal, well drained and with lots of bases. Other soil types are vertic or melanic clays, which are characterised by expansion and contraction during the wet and dry seasons, respectively (Mucina *et al.*, 2005).

Of the three towns, this town receives the lowest rainfall. Zeerust receives summer rainfall ranging between 550 and 600 mm per annum (Mucina *et al.*, 2005). The rains in this town are unreliable.

Droughts and frost are common in winter. According to Mucina *et al.* (2005), Zeerust experience a mean monthly maximum temperature of 36.7 °C in January and the coldest month is June with a minimum of just below the freezing point (-0.4 °C). This is the second coldest of the three towns.

Chapter Two

The abundance, distribution, richness and attributes of homestead trees in different urban areas

1 Introduction

During the 20th century, global urbanisation rapidly increased resulting in the majority of the world's population living in urban areas (Singh *et al.*, 2010), rising from ten percent to over 50% and is expected to reach 67% in the next 50 years (Grimm *et al.*, 2008). Even though the global urban population is currently above 50%, developing countries still have large rural majorities (Montgomery, 2008; UN-Habitat, 2009). In 2003, Africa's urban population stood at 39% and in the next few decades it is expected to reach 54% (United Nations, 2004). Although Africa as a whole has a minority urban population, this proportion is not the same across the continent with some countries having a majority urban population. The typical example is South Africa with an urbanisation rate estimated at 56.3% (Lehohla, 2006), accompanied by decreasing rural populations. Just within five years, from 1996 to 2001, the rural population decreased from 44.9% to 42.5% (Simbi and Aliber, 2000; Stats SA, 2001).

The rapid increase of urban populations in developing countries, South Africa inclusive, is posing challenges on the planning and service delivery abilities of municipalities. High urbanisation rates put pressure on land and natural resources, e.g. provision of food, energy and wood for building. Urban forestry is perceived to be one approach which can help reduce the multiple challenges brought about by rapid urbanisation. Urban forestry is a practice of planting, managing and caring for trees in urban and peri-urban areas to attain economic, environmental and social benefits for urban residents (Horst, 2006; NFAP, 1997). Some examples of urban forests include trees on private property such as trees on homesteads, public green spaces such as street trees and parks, and trees on the edges of towns (Bentsen *et al.*, 2010; Fuwape and Onyekwelu, 2011; Horst, 2006). These trees provide a wide range of benefits to contribute to the basic needs of urban residents. These services can be divided into two; firstly, consumptive tree products (fruits, fuelwood, wood for building and fencing) and secondly, non-consumptive tree products which include, habitat protection, watershed and soil protection, carbon sequestration, and many more (Adekunle and Agbaje, 2012; Fuwape and Onyekwelu, 2011; Kuchelmeister, 2001). During urbanisation, residential areas are established by clearing land in and on the edges of towns which can adversely affect the abundance and richness of urban forests (McConnachie *et al.*, 2008). Hence, there is need for planners and conservationists to reduce the negative effects of urbanisation (Cilliers *et al.*, 2004) by sensitising the urban migrants to the benefits of urban forests.

Trees in urban forests consist of different species which can either be established by retaining existing trees (*in-situ*) or planting new trees on pieces of land (Paumgarten *et al.*, 2005; Shackleton, 2006). Residents retain certain tree species on their stands when they establish their homesteads, plant some trees from outside (*ex-situ*) and others can allow trees to self-seed. This is done out of the residents' appreciation of trees, particularly because of the observed and anticipated benefits that trees provide people and the environment (Uddin and Hasan, 2001). As part of urban forests, trees on homesteads are cardinal as they provide consumptive tree products which enhance livelihoods and well-being of urban residents (Alvey, 2006; Shackleton, 2006). Trees on homesteads are beneficial to residents as sources of fruits, fuelwood, wood for building, wood for fencing, medicines, propagation material and the like (Adekunle and Agbaje, 2012; Fuwape and Onyekwelu, 2011; Shackleton, 2006). Trees in urban areas however, are not equally distributed across different residential areas; older established residential areas are endowed with more trees compared to the newly established residential areas with very few trees in private and public green spaces (Kuruner-Chitepo and Shackleton, 2011; McConnachie and Shackleton, 2010).

South African towns are heterogeneous, divided into formal and informal residential areas. Formal residential areas are planned with permanent houses such as affluent residential areas, townships and RDP residential areas, while informal residential areas are established on unused land and the houses are made of poor quality building materials (UN-Habitat, 2003; Stats SA, 2001). Different residential areas have different homestead plot sizes. Trees on homesteads can only be planted or maintained when plot sizes are large enough to enable residents to establish them (Venn and Niemela, 2004). The homestead plots in the RDP residential areas are the smallest, followed by the township being medium and affluent residential areas typically have the largest and with a high number of trees compared to the other residential areas (McConnachie and Shackleton, 2010). Even though RDP residential areas are recently developed residential areas, they are the smallest with very few public green spaces and they have the highest number of people per household compared to the other two residential areas (McConnachie and Shackleton, 2010). On the other hand, informal residential areas are worse off as they are characterised by poor water supply and sanitation, poor quality housing structures, and are typically densely over crowded. Wealthier and more educated households typically have higher densities of trees on homesteads (Barbosa *et al.*, 2007; Zhang *et al.*, 2008). They are able to acquire property with large plot sizes which enable them to plant more trees. RDP residential areas have very few public green spaces than the older township (McConnachie and Shackleton, 2010). Similarly richer residential areas recorded higher numbers of trees in public green spaces than poorer ones (McConnachie *et al.*, 2008).

This is replicated on a town scale, highly populated towns with lower income levels have fewer public green spaces characterised by few trees, lower species richness and a high percentage of alien tree

species (McConnachie *et al.*, 2008). In addition, towns with a lot of informal residential areas have poor green spaces (McConnachie *et al.*, 2008). This applies to street trees too (Kuruneri-Chitepo and Shackleton, 2011).

Most of the studies conducted on urban forestry in Africa and other developing countries around the world, have shown that these urban forest resources are dominated by alien tree species. Kuruneri-Chitepo and Shackleton (2011) found that 56% of street trees were alien; similarly, McConnachie *et al.* (2008) reported that 59.9% of trees that make up public urban green spaces are alien to South Africa. Other studies in West Africa also show the same trends, e.g. higher proportions (69%) of trees in Togo were alien trees (Raoufou *et al.*, 2011), with a very high percentage (77%) reported in Ivory Coast (Ake, 2002). Correspondingly, floristic elements in Bangladesh, Brazil and Nigeria have more alien than indigenous trees (Alam and Masum, 2005; Ndaeyo, 2007; Winklerprins and de Souza, 2005). In addition, trees on homesteads are commonly dominated by fruits trees (Bernholt *et al.*, 2009; Paumgarten *et al.*, 2005; Uddin and Hasan, 2001). Edible fruits recorded in urban forests in Lome, include *Citrus sinensis*, *C. limon*, *M. indica*, *Artocarpus altilis*, *Coccoloba uvifera* and *C. nucifera* (Raoufou *et al.*, 2011). The most common trees on homesteads in Bangladesh (Alam and Masum, 2005), Nigeria (Ndaeyo, 2007) and Brazil (Winklerprins and de Souza, 2005) were *Psidium guajava*, *Mangifera indica* and *Carica papaya*. Common trees that form part of street trees in Port Alfred, Grahamstown and Somerset East are *Erythrina caffra*, *Grevillea robusta* and *Jacaranda mimosifolia* (Kuruneri-Chitepo and Shackleton, 2011). This situation is not the same with developed countries. For example, Pysek (1998) in Europe, Clement and Moore (2003) in America and Frank *et al.* (2006) in Australia, reported lower percentages of alien tree species to be 40.3, 32.1 and 40%, respectively. This shows that the developed countries have higher percentage of indigenous trees which is not the case for the developing countries.

Trees encountered in urban areas are used for multiple purposes (Fuwape and Onyekwelu, 2011; Raoufou *et al.*, 2011). Multipurpose tree species, according to Long and Nair (1999), are tree species which provide many benefits. Residents may plant trees for fruits which they may use for fuelwood later on (Uddin and Hasan, 2001). In addition to the consumptive tree products, the main focus of this research, trees on homesteads serve as biodiversity node (Jim and Chen, 2009).

Even though urban forests offer many consumptive and non-consumptive tree products which benefit urban residents and the environment, little work has been done in this field (Kuruneri-Chitepo and Shackleton, 2011; Raoufou *et al.*, 2011; Uddin, 2006). There have been some studies on the distribution, richness and attributes of street trees. However, not much has been done in regard to trees on homesteads in urban areas. This is because urban forestry has been neglected as the contribution of trees is perceived to be small and not important to the livelihoods of the people in urban areas. Developing countries view urban forestry and greening as an emerging and a young science (Bentsen

et al., 2010; Kuchelmeister, 1999) despite potentially having the same benefits as natural forests. Hence, many countries and international forestry organisations have yet to put urban forestry on their agenda (Kuchelmeister, 1999; Shackleton, 2006). However, this is not the case with the developed countries; Europe and America have done so well in this field (Konijnendijk *et al.*, 2004) although most of the attention has been paid to the non-consumptive benefits that urban trees provide. Hence, there is need to characterise the species present on homesteads, their distribution, richness, and their importance to livelihoods of urban residents. Thus, the key question for this chapter was “What is the abundance, distribution and richness of homestead trees in different urban residential areas?”

2 Methods

2.1 Pilot study

A pilot study precedes the final research targeted at respondents with similar characteristics (de Vos, 1998; Jackson, 1995; Wilson, 1996) and helps to determine the effectiveness of sampling methods, and level of responses of interviewees (Burton, 2000). It also guides what questions should be included in the interview schedule and their wording. Preceding data collection, a pilot study was conducted in Grahamstown in two residential areas, the informal and township residential areas. The time it took to finish one interview was determined and unclear questions were noted and changes were made before printing the interview sheets.

2.2 Sampling

The selection of households within each town was carried out using aerial photographs (scale: 1: 5 000). The surface area of each town was divided into three residential areas, i.e. the township, RDP and informal residential areas, facilitating a stratified sampling approach. Settlement boundaries were defined, which were then used to select a random sample in Microsoft Excel. The sample size was 450 households, 150 households from each town and 50 from each urban residential area.

It was initially planned to conduct the study in four residential areas. However, the affluent residential area was excluded because residents in this area were not keen to participate when approached to be interviewed. Therefore, a second strategy was attempted in which I contacted a security company to supply me with client telephone numbers but the firm was not willing to help. I tried also to distribute an information brochure for the project but this also failed. Hence, the study was only conducted in three residential areas namely the township, RDP and informal residential areas.

2.3 Trees in homesteads

At each selected household, the area of the homestead plot was measured and all trees on each plot were recorded. Tree attributes such as basal circumference (at 35 cm above ground level) and species

were recorded. A dress maker's tape was used to measure the basal circumference for trees with a circumference greater than 30 cm while a digital calliper was used to measure the diameter of small tree stems. Circumference was calculated using the formula $C = \pi d$ (d is the diameter) correct to one decimal place. Specimens were collected, labelled and pressed for identification. Young trees below 40 cm tall were only counted and the species noted. The density of trees was determined by dividing the number of trees by the area of the homestead.

2.4 Carbon content

The circumference at basal height was expressed into diameter ($d = c/\pi$), which was then converted into diameter at breast height (DBH) using a regression equation [DBH = 0.7696(Basal diameter) + 0.9296; $r^2 = 0.8711$, $n = 130$]. This was used to determine the above ground biomass (ABGB) through the use of the allometric equation [ABGB = 0.127(D)^{2.335}] (Mangwale, 2010). The above ground biomass was then multiplied by 0.5 to give the above ground carbon content (Stoffberg *et al.*, 2010; van Deusen, 2010). The carbon stocks in trees were then expressed in kg per household and kg per hectare.

2.5 Use of trees and tree products

A structured interview schedule (Appendix 1) with both open ended and closed ended questions was formulated. According to Burton (2000) and Wheater and Cook (2000) open ended questions allow the respondent to answer freely without restrictions, while closed ended questions limit the respondent. Hence, the discussion is controlled by the interviewer, who asks for specific data (Allison *et al.*, 1996). The first part of the interview schedule was used to record if there were trees on the homestead and how they were established, how the planting material was acquired and changes in the number of trees on the yard.

The household head was interviewed if present, but where absent, any adult member of the family was interviewed. The interviewees were encouraged to ask other family members when answering some questions related to costs and quantities of different tree products. Data collection included weekends and public holidays to accommodate people who work. If nobody was present at a selected household, or if the household head refused to be interviewed, the next randomly selected household on the sample frame was interviewed. Interviews were conducted in English or interpreted into a preferred local language. Each interview lasted approximately one hour.

2.6 Observation and note taking

Observations are an important tool for data collection as they aim at recording, analysing and interpreting behaviour and actions of a subject of interest (Ritchie, 2003). Observations provide the

opportunity to check and corroborate data collected from other research methods (Foster, 1996) and allow the researcher to scrutinise what is happening in real life situations (Denscombe, 2007). In addition, observations enable the researcher to check if the questions are correctly answered (Angelsen and Lund, 2011). The other method was note taking, this is a non-verbal method of data collection (Neuman, 2003). Furthermore, note taking enables the researcher to understand the behaviour of respondents and their level of agreement (e.g. head shaking).

3 Data analysis

Prior to data analysis, the answers to the structured interview schedule were coded. Coding is the process by which interviewees' responses are transformed (e.g. open or closed ended questions) into numbers or letters. This process is important in research surveys as it facilitates numeric data analysis (Neuman, 2003). Coded qualitative and quantitative data were entered into Microsoft Excel. The qualitative and quantitative data were analysed using the Statistica 10. Descriptive statistics such as bar graphs, histograms, frequency tables and percentages were created. Initial data exploration via principle components analysis (PCA) was used to portray the relationships between household data and tree data. For normally distributed data, a two-way ANOVA was used to analyse continuous data and compare town and suburbs simultaneously, however a non-parametric test (Kruskal-Wallis test) was used for data which were not normally distributed, A Chi square (χ^2) in the form of 2 x 2 contingency tables were used to compare the percentages of indigenous and alien tree species and Spearman rank order correlation was used to see if there were associations between area and number of tree species per household and tree density. In all analyses a significance level of confidence was at 5%.

4 Results

4.1 Homestead plot size

Homestead plots varied from town to town and one residential area to another. Across towns, households in Tzaneen recorded the largest homestead plots, followed by Bela Bela and the smallest were at Zeerust. Tzaneen and Bela Bela had significantly larger ($H = 18.0$; $p = 0.0001$) homestead plots ($1\ 876.2 \pm 1\ 152.9\ m^2$ and $1\ 762.0 \pm 828.8\ m^2$) than Zeerust ($1\ 507.6 \pm 1\ 511.3\ m^2$). Across residential areas, the township and informal residential area had significantly larger ($H = 20.6$; $p = 0.00001$) homestead plots than the RDP residential area (Table 2.1). This trend resembled the number of years the household head had lived in the house (Appendix 2), thus the older the residential area, the larger the homestead plot.

Table 2.1: Homestead plot and homestead tree attributes. (Comparing towns, unlike superscripts represent significant differences within columns. Note: The number of species and percentage of indigenous trees do not include the unknown species)

Town	Residential areas	Attributes							
		Plot size (ha)	% hh with trees	Mean no. of trees/hh	Mean circum. (cm)	No. of spp.	Mean no. of spp/hh	Indigenous trees	
								% of spp.	% of total no. tree
Tzaneen	Informal	0.3±0.1 ^a	98	17.9±14.7 ^a	46.5±34.2 ^a	38	5.6±2.9 ^a	50.0	8.6
	RDP	0.1±0.1 ^a	78	5.8±7.0 ^a	10.6±12.3 ^a	19	2.6±1.5 ^a	36.8	5.3
	Township	0.2±0.1 ^a	94	8.3±5.7 ^a	70.7±47.6 ^a	19	3.7±1.9 ^a	20.0	6.9
	All	0.2±0.1^a	90	10.7±9.1^a	42.6±31.4^a	42	4.0±2.1^a	47.6	7.7
Bela Bela	Informal	0.1±0.03 ^b	82	4.9±4.4 ^b	22.4±18.7 ^b	29	2.9±2.2 ^b	48.3	30.7
	RDP	0.2±0.1 ^b	80	5.5±4.7 ^a	14.1±14.9 ^a	32	3.2±2.0 ^a	46.7	27.7
	Township	0.3±0.1 ^b	100	9.2±8.0 ^a	53.7±51.9 ^b	50	5.8±3.8 ^b	43.5	16.5
	All	0.2±0.1^a	87	6.5±5.7^b	30.1±28.5^b	66	4.0±2.7^a	54.5	22.6
Zeerust	Informal	0.2±0.04 ^b	96	6.2±3.7 ^b	22.7±29.6 ^b	35	3.6±1.8 ^{ab}	43.8	54.1
	RDP	0.1±0.04 ^b	100	6.7±4.4 ^a	29.5±29.3 ^b	26	3.5±2.0 ^a	40.0	34.4
	Township	0.1±0.3 ^c	86	4.9±2.8 ^b	33.2±32.9 ^c	22	2.8±1.4 ^a	23.8	8.6
	All	0.2±0.1^b	94	5.9±3.6^b	28.5±30.6^c	42	3.3±1.7^a	42.9	34.9
Combined	Informal	0.2±0.1 ^a	92	9.7±7.6 ^a	30.5±27.5 ^a	73	4.0±2.3 ^b	58.9	21.6
	RDP	0.1±0.1 ^b	86	6.0±5.4 ^b	18.1±18.8 ^b	52	3.1±1.8 ^a	50.0	24.0
	Township	0.2±0.2 ^a	93	7.5±5.5 ^a	52.5±44.1 ^c	60	4.1±2.4 ^b	45.0	10.8
	All	0.2±0.1	90	7.7±6.1	33.7±30.2	62	3.8±2.2	55.4	18.7

4.2 Distribution and abundance of trees on homesteads

Most households (90%) had trees on their homesteads. On average, Zeerust recorded the highest percentage of households with trees, followed by Tzaneen and Bela Bela had the least (Table 2.1). Comparing residential areas, the township recorded the highest percentage (93%) of households with trees and the RDP area had the least (86%). Two residential areas (the township and RDP area) in Bela Bela and Zeerust recorded a 100% of households with trees on homesteads.

The total number of trees counted on the 450 sample households was 3 217. Most trees were encountered in Tzaneen which had 1 494 (46.4%) trees, followed by Bela Bela 884 (27.5 %) and Zeerust 839 (26.1%). The informal residential area recorded more (42.8%) trees than the township which was also greater (32.9%) than the RDP residential area. Even though most homesteads had trees, there were differences in the sizes (height) of trees. Bela Bela had the highest percentage of small (less than 40 cm tall) trees (11%), Tzaneen was intermediate (9%) and Zeerust had the least (4%). Among residential areas, the RDP areas had the highest proportion of small trees followed by the informal and the least was recorded in the township (Figure 2.1).

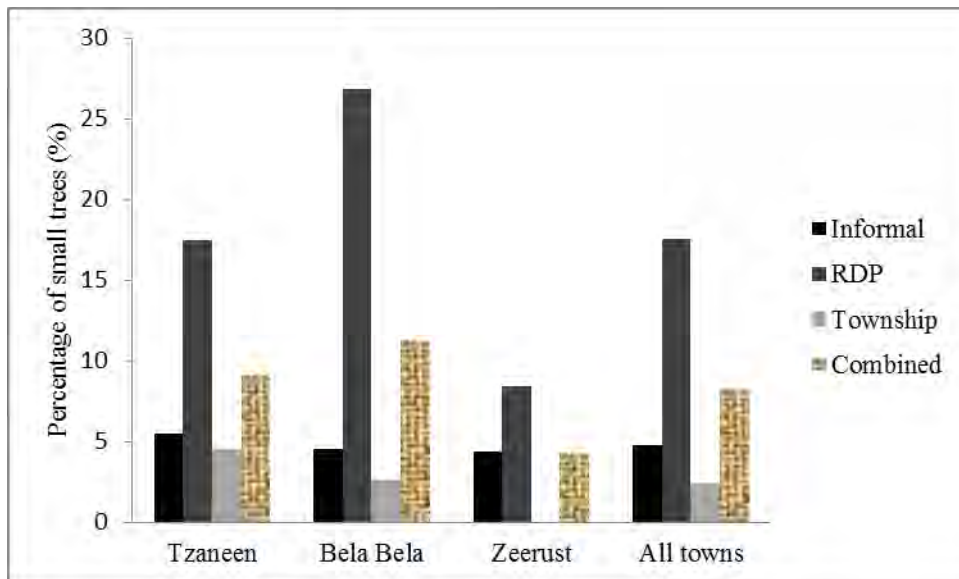


Fig. 2.1: Percentage of trees less than 40 cm tall in three towns

The mean number of trees per household was reflected in the total number of trees in each town and residential area. The town and residential area with the highest number of trees also had the highest mean number of trees per household. The mean number of trees per household in Tzaneen was significantly ($H = 19.0$; $p = 0.0005$) larger (10.7 ± 9.1) than Bela Bela and Zeerust (Table 2.1). Considering residential areas, the RDP residential area had significantly ($H = 11.8$; $p = 0.0027$) lower (6.0 ± 5.4) mean number of trees per household than the township and informal residential areas. There was a positive correlation between homestead plot size and the number of trees per homestead in the informal residential areas ($r = 0.5$; $p < 0.05$) and township residential areas ($r = 0.2$; $p < 0.05$).

4.3 Tree density

The town with the highest number of trees (Tzaneen) also had the highest tree density, however in Zeerust even though the residents had the fewest number of trees, had a higher tree density than Bela Bela. Considering residential areas, the informal residential area had the highest tree density, followed by the township and the RDP residential area generally had the least, however the RDP area in Zeerust had the third highest tree density (Table 2.2).

Tzaneen and Zeerust had significantly ($H = 14.0$; $p = 0.0009$) larger tree density (59.3 ± 16.2 and 47.3 ± 10.1 trees per ha) than Bela Bela. Across residential areas, the informal residential area had significantly ($H = 6.3$; $p = 0.04$) higher tree density (53.0 ± 17.4 trees per ha) than the township and RDP residential area (Table 2.2). This is despite the township being older than the other two residential areas and particularly that density is not determined by the size of trees.

Table 2.2: Mean (\pm sd) tree density per hectare for the three towns and residential areas. (Note: Comparing towns, unlike superscripts represent significant differences within rows)

Res. area	Town			
	Tzaneen	Bela Bela	Zeerust	All
Informal	71.7 \pm 72.8 ^a	41.0 \pm 41.3 ^b	37.3 \pm 26.4 ^b	53.0\pm17.4^a
RDP	40.9 \pm 56.2 ^a	27.9 \pm 30.8 ^a	57.4 \pm 58.9 ^a ^b	42.1\pm14.8^b
Township	65.2 \pm 16.1 ^a	37.0 \pm 33.6 ^a	47.1 \pm 67.9 ^a	49.8\pm14.3^b
All	59.3\pm16.2^a	35.3\pm7^b	47.3\pm10.1^a	48.3\pm5.6

4.4 Tree basal circumference at basal height

In terms of tree circumference, trees in Tzaneen were significantly ($H = 170.8$; $p = 0.0003$) larger (42.6 ± 31.4 cm) than trees in Bela Bela, which in turn, were larger than trees in Zeerust. Across residential areas, the Kruskal-Wallis test showed that the older the residential area, the larger the tree circumference. Therefore, trees in the township had significantly ($H = 357.3$; $p = 0.00001$) larger circumference than trees in the informal residential area, which also had tree circumference larger than the RDP residential area (Table 2.1).

The circumference class interval between zero and 25 cm had the highest number of trees, signifying that most of the trees were recently established on homesteads (Figure 2.2). In all residential areas across all towns, there was only one tree which had a circumference greater than 310 cm (*Diospyros mespiliformis*), found in Tzaneen's informal residential area. The township in Bela Bela had the largest circumference in the class of 250.1-275.0 cm while the informal residential area in Zeerust had the largest circumference in the class of 225.1-250.0 cm. The general pattern was that, as class circumference increased, the number of trees decreased. The RDP residential area in Tzaneen had no trees with a circumference greater than 75 cm and similarly, the RDP residential area in Bela Bela had no trees with circumference greater than 100 cm.

4.5 Carbon content stored in trees on homesteads

Trees on urban homesteads stored an average of 54.3 ± 18.0 kg of carbon per household and 106.8 ± 166.0 kg per ha in the above ground biomass (Table 2.3). A significantly ($H = 30.4$; $p = 0.00001$) larger amount (166.1 ± 223.7 kg per ha) of carbon was stored in homestead trees in Tzaneen, the town with the highest density of trees, followed by Zeerust and lastly Bela Bela (83.9 ± 195.2 kg per ha) with no significant differences. However, the pattern did not follow the trend exhibited by tree density across residential areas. Instead, the township had significantly ($H = 79.2$; $p = 0.00001$) larger quantities (207.5 ± 331.0 kg per ha) of carbon stored in above ground biomass of trees, followed by the informal residential areas being significantly larger than carbon stored in the RDP areas (33.2 ± 53.3 kg per ha).

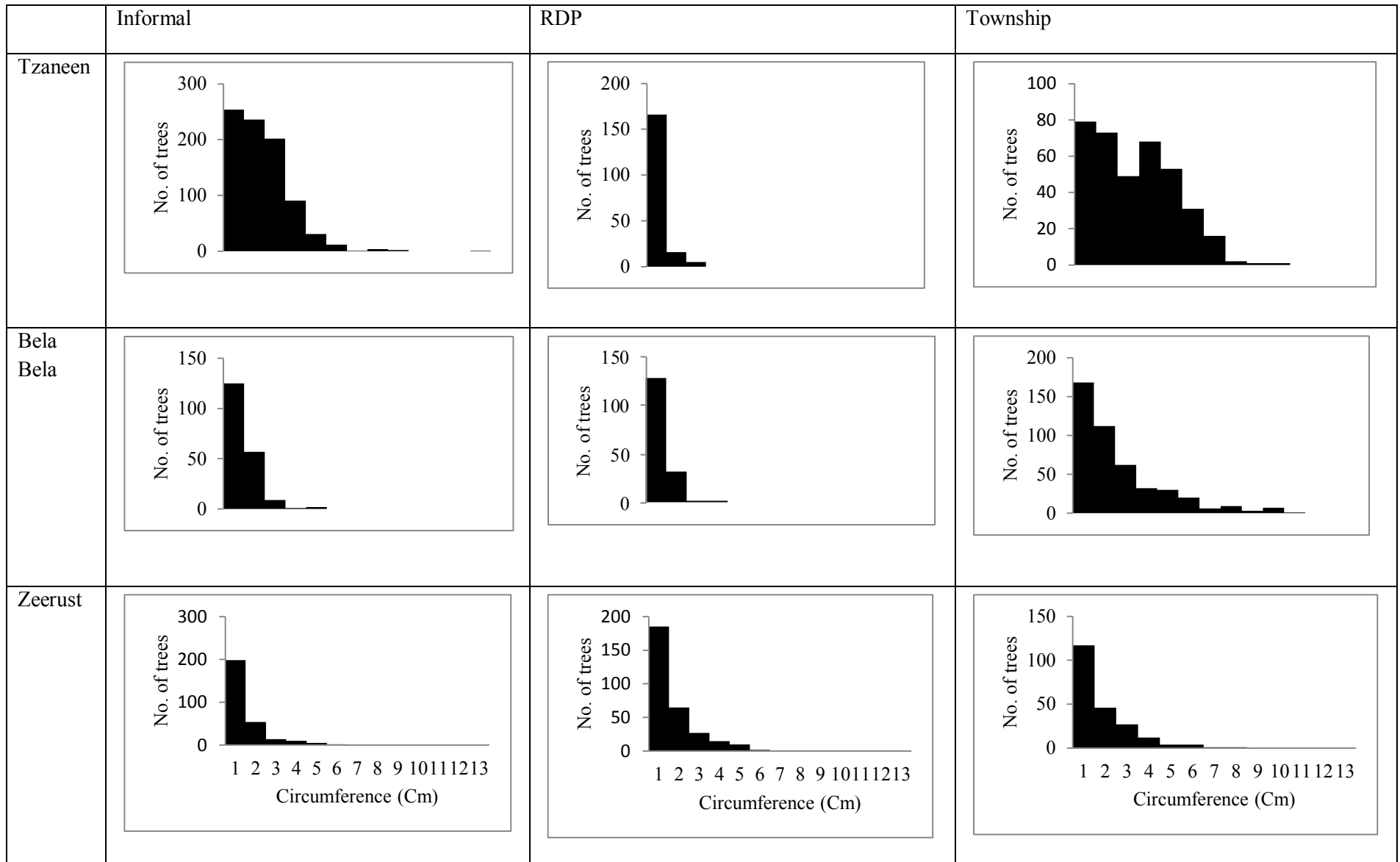


Figure 2.2: Size class profile of trees (Circumference size classes in 25 cm interval)

Table 2.3: The mean (\pm sd) above ground homestead tree carbon per household and carbon per hectare in kg (Comparing towns, unlike superscripts represent significant differences within columns)

Town	Res. Area	Carbon(Kg)/hh	Carbon(Kg/ha)
Tzaneen	Informal	43.5 \pm 54.2 ^a	170.3 \pm 243.9 ^a
	RDP	1.3 \pm 1.3 ^a	13.1 \pm 13.5 ^a
	Township	46.2 \pm 29.5 ^a	314.8 \pm 413.7 ^a
	All	30.3\pm28.3^a	166.1\pm223.7^a
Bela Bela	Informal	2.6 \pm 4.5 ^b	24.0 \pm 39.2 ^b
	RDP	1.9 \pm 3.1 ^a	12.1 \pm 19.9 ^a
	Township	43.6 \pm 41.5 ^a	175.0 \pm 182.2 ^b
	All	16.0\pm16.4^b	70.3\pm80.4^b
Zeerust	Informal	7.7 \pm 10.5 ^{ab}	44.7 \pm 61.8 ^{ab}
	RDP	7.7 \pm 8.3 ^b	74.4 \pm 126.6 ^b
	Township	8.2 \pm 9.3 ^b	132.6 \pm 397.2 ^c
	All	7.9\pm9.3^{ab}	83.9\pm195.2^{ab}
Combined	Informal	53.7 \pm 23.1 ^a	79.7 \pm 115.0
	RDP	11.0 \pm 4.2 ^b	33.2 \pm 53.3
	Township	98.1 \pm 26.8 ^c	207.5 \pm 331.0
	All	54.3\pm18.0	106.8\pm166.4

4.6 Tree species richness

The mean number of tree species per household ranged between 2.6 \pm 1.5 and 5.8 \pm 3.8 (Table 2.1). Considering towns, each averaged three to four species per household and there were no significant differences among them. Across the residential areas, the township and informal residential area had significantly ($H = 9.6$; $p = 0.008$) more tree species per household (4.1 \pm 2.4 species) than the RDP residential area (Table 2.1).

4.7 Tree establishment

Most of the trees in all towns were planted by the current occupants (71.1%), while fewer trees were already on the homesteads when the respondents moved onto the plots, and others were self seeded. More respondents collected propagation material from the neighbours, friends, relatives and neighbourhoods than they bought from retail outlets. Others retained trees on their homesteads when they constructed their houses, notably over half of households in the informal residential area and RDP in Zeerust retained trees (Table 2.4).

Table 2.4: Modes of tree establishment (Some respondents gave more than one answer; therefore totals can exceed 100%)

Town	Residential area	Mode of tree establishment (%)			Propagation material (%)	
		Planted	Already there	Self-seeded	Bought	Collected
Tzaneen	Informal	92	4	12	46	80
	RDP	76	4	2	8	66
	Township	78	16	8	46	60
	All	88.7	8.0	7.3	33.3	68.7
Bela Bela	Informal	62	20	20	14	52
	RDP	60	26	22	24	36
	Township	74	30	20	18	42
	All	65.3	25.3	20.7	18.7	43.3
Zeerust	Informal	68	54	26	4	64
	RDP	78	50	36	2	76
	Township	52	30	20	6	46
	All	66.0	44.7	27.3	4.0	62.0
Combined	Informal	74	26	19.3	21.3	65.3
	RDP	71.3	26.7	20	11.3	55.3
	Township	68	25.3	16	23.3	49.3
	All	71.1	26.0	18.4	18.6	56.6

4.8 Dominant tree species

The tree species were not evenly distributed across and within towns, but they were characterised by certain tree species emerging as dominants. The notable ones were *M. indica* in Tzaneen, *Tecoma stans* and *Prunus persica* in Bela Bela and in Zeerust *P. persica* was dominant (Table 2.5). Considering the top seven tree species on homesteads in the three towns, it was evident that there were more fruit trees than non-fruit trees. During planting and retaining of trees on homesteads by urban households, preference is primarily given to consumptive benefits than non-consumptive benefits.

4.9 Indigenous and alien tree species on home plots

Overall, there were more alien than indigenous tree species. However, the informal residential area had more indigenous tree species than the RDP residential area which had also more than the

township (Table 2.1). This suggests that the residents in the informal residential area retained most of the tree species during the establishment of their houses. The township in Tzaneen had significantly ($\chi^2 = 13.2$; $df = 1$; $p = 0.0003$) more alien trees (80%) than the one in Bela Bela, similarly the one in Zeerust had significantly ($\chi^2 = 8.9$; $df = 1$; $p = 0.003$) more alien trees than Bela Bela (Table 2.1).

Alien tree species dominated the top seven tree species in each residential area and they were mainly fruit tree species (Table 2.5). Among the alien trees recorded, were *T. stans*, *P. guajava*, *L. lucidum* and *J. mimosifolia* which are regarded as invasive in South Africa. According to legislation, these tree species are classified as invasive alien tree species (Nel *et al.*, 2004). Across all towns, the informal residential areas had the largest percentages of indigenous trees whilst the township recorded the lowest proportions. The inventory results show that urban residents prefer alien trees species over indigenous tree species.

4.10 Trends in tree abundance over the past five years

More respondents felt that the numbers of trees on homesteads were increasing than those who thought they were decreasing (Table 2.6). This trend was evident across all towns and in all residential areas. The main reason given for the increase was that people were planting more trees and other trees were self-seeding. The decrease was associated with trees being cut down to allow for expansion of houses in the township in Tzaneen, Bela Bela and Zeerust. In addition, some respondents expressed sadness that trees on their homesteads were cut down, and wished that the plots were a bit larger so that they could plant more trees. The other reason given was that there was no more space to plant more trees. Respondents in the informal and RDP residential area in Bela Bela noted that the decrease was due to a lack of water, poor soil conditions and browsing.

Table 5: The seven most common tree species for three towns (Indigenous tree species are in bold type)

Town	Residential area								
	Informal	% hh	% trees	RDP	% hh	% trees	Township	% hh	% trees
Tzaneen	<i>Mangifera indica</i>	98	66.6	<i>Mangifera indica</i>	74	45.1	<i>Mangifera indica</i>	94	54.2
	<i>Carica papaya</i>	42	7.1	<i>Carica papaya</i>	30	25.7	<i>Carica papaya</i>	40	13.6
	<i>Persea americana</i>	38	3.8	<i>Persea Americana</i>	18	5.8	<i>Persea americana</i>	32	4.6
	<i>Psidium guajava</i>	26	2.0	<i>Psidium guajava</i>	14	4.4	Palm	30	5.9
	<i>Citrus limon</i>	22	2.3	<i>Thuja occidentalis</i>	14	4.4	<i>Citrus limon</i>	24	4.1
	<i>Sclerocarya birrea subsp. caffra</i>	20	2.3	<i>Citrus limon</i>	10	2.2	<i>Citrus sinensis</i>	24	3.1
	<i>Prunus persica</i>	18	1.5	<i>Malus domestica</i>	6	2.2	<i>Litchi chinensis</i>	16	2.3
	Total		85.6			89.8			87.8
Bela Bela	<i>Prunus persica</i>	40	14.4	<i>Prunus persica</i>	44	24.5	<i>Prunus persica</i>	58	13.9
	<i>Tecoma stans</i>	40	22.8	<i>Acacia karroo</i>	30	15.0	<i>Citrus limon</i>	44	8.7
	<i>Morus nigra</i>	34	12.9	<i>Mangifera indica</i>	26	9.1	<i>Morus nigra</i>	40	6.1
	<i>Acacia tortilis</i>	12	8.4	<i>Persea americana</i>	24	5.9	<i>Mangifera indica</i>	38	8.0
	<i>Citrus limon</i>	12	3.5	<i>Citrus limon</i>	18	5.0	<i>Carica papaya</i>	36	6.3
	<i>Persea americana</i>	10	3.5	<i>Psidium guajava</i>	14	5.0	<i>Jacaranda mimosifolia</i>	34	6.1
	<i>Dodonaea viscosa</i>	8	8.4	<i>Tecoma stans</i>	12	4.5	<i>Persea americana</i>	30	5.6
	Total		73.9			69.0			54.7
Zeerust	<i>Searsia lancea</i>	56	18.9	<i>Prunus persica</i>	78	30.2	<i>Prunus persica</i>	54	24.9
	<i>Prunus persica</i>	48	19.3	<i>Acacia sp. (Mosu)</i>	36	14.7	<i>Ligustrum lucidum</i>	42	32.1
	<i>Ziziphus rivularis</i>	46	11.0	<i>Ligustrum lucidum</i>	32	14.1	<i>Morus nigra</i>	40	12.9
	<i>Morus nigra</i>	36	8.1	<i>Searsia lancea</i>	32	6.0	<i>Vitis vinifera</i>	22	6.2
	<i>Acacia sp. (Mosu)</i>	26	8.4	<i>Morus nigra</i>	22	4.8	<i>Ficus sp. (Feiye)</i>	16	4.3
	<i>Ficus sp. (Feiye)</i>	20	5.4	<i>Vitis vinifera</i>	18	3.0	<i>Citrus limon</i>	12	3.3
	<i>Malus domestica</i>	16	5.1	<i>Ziziphus rivularis</i>	16	3.0	<i>Citrus sinensis</i>	8	2.9
	Total		76.2			75.8			86.6

Table 2.6: Percentage of responses on trends in tree abundance in the past five years (Note: Due to rounding off, some figures do not add up to 100%)

Town	Res. area	Change over the past five years			Type of change		Causes of change		
		No change	Change	No response	Increase	Decrease	Plant more	Cut down	Die
Tzaneen	Informal	24	74	2	50	24	46	22	0
	RDP	72	4	24	2	2	2	0	2
	Township	28	66	6	24	42	24	42	0
	All	41.3	48.0	10.7	25.3	22.7	24.0	21.3	0.7
Bela Bela	Informal	24	56	20	40	16	42	6	8
	RDP	40	38	22	26	12	28	0	12
	Township	46	50	4	38	12	38	8	4
	All	36.7	48.0	15.3	34.7	13.3	36.0	4.7	8.0
Zeerust	Informal	80	16	4	12	4	10	4	2
	RDP	72	28	0	24	4	24	4	0
	Township	70	16	14	14	2	14	2	0
	All	74.0	20.0	6.0	16.7	3.3	16.0	3.3	0.7
Combined	Informal	42.7	48.7	8.7	34	14.7	32.7	10.7	3.3
	RDP	61.3	23.3	15.3	17.3	6	18	1.3	4.7
	Township	48.0	44	8.0	25.3	18.7	25.3	17.3	1.3
	All	50.7	38.7	10.6	25.5	13.1	25.3	9.8	3.1

4.11 Relationships between household and tree attributes

Various household characteristics affect the planting and management of trees. The circumference of trees was positively associated with the type of residential area (Figure 2.3). The township therefore had trees with larger circumferences. This residential area is the oldest among the three residential areas (Appendix 2) suggesting that trees in this residential area were fairly old. However, the township had fewer indigenous tree species than the informal residential area. Similarly, households with higher cash income had more alien trees than those households which earned lower cash income. It must be noted however the PCA results did not show strong relationships between various variable.

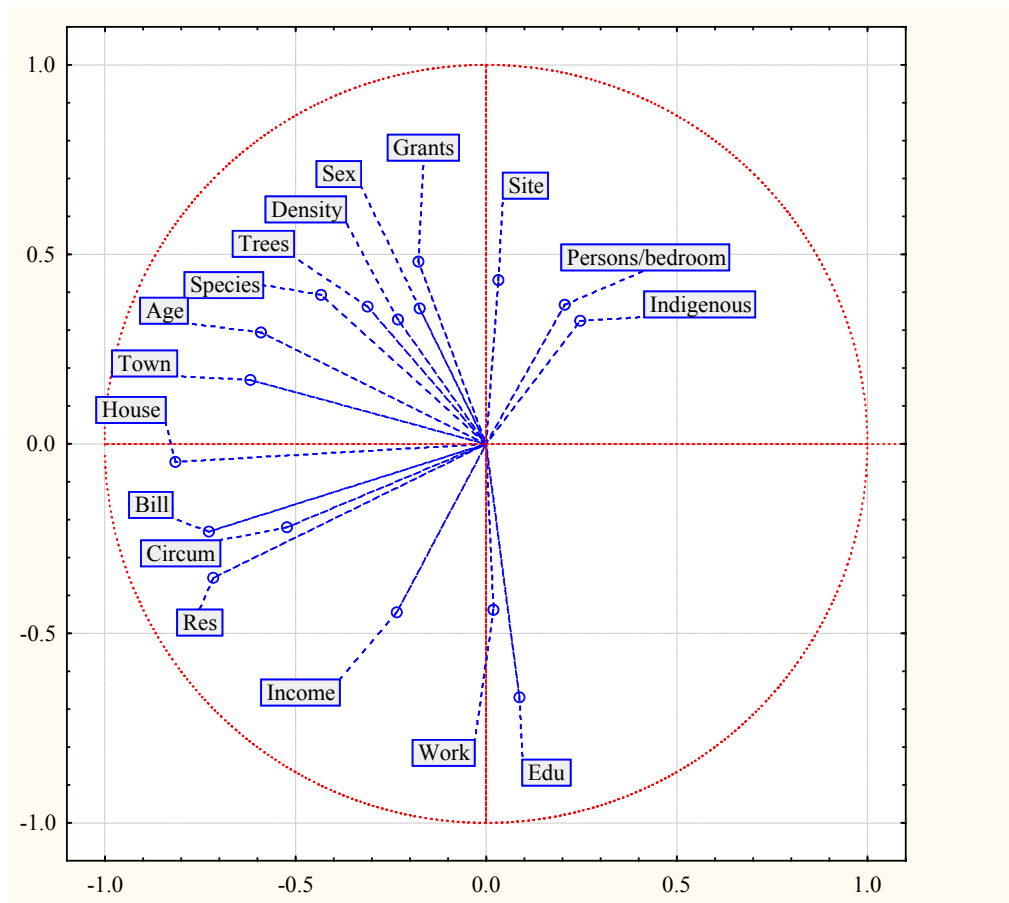


Figure 2.3: PCA vector plot of tree and household attributes (Axis 1 = 17.9% of variance; Axis 2 = 13.5% of variance).

5 Discussion

5.1 Characteristics of tree holdings on urban homesteads

This study clearly shows that urban residents actively plant and manage trees on their homesteads, even though this practice is frequently ignored by researchers, governments and international forestry organisations (Kuchelmeister, 1999; Shackleton, 2006). This may counter the view that people in urban areas (especially those in informal residential areas) contribute to urban forest degradation. Decline in vegetation composition can be attributed to clearance of entire area during construction of residential areas such as RDP houses. However, this can be determined by assessing vegetation changes over a period of time. In this study, most homesteads in the township and informal areas had trees and the residential area with the least percentage of homesteads with trees was 78%, which was in the RDP residential area. In addition, over 70% of households planted trees while a quarter retained trees on homesteads. Urban residents plant and maintain trees on their homesteads to benefit from the various consumptive and non-consumptive products that trees provide, despite being limited by inadequate space and adverse conditions.

Overall, the township emerged as the residential area with the largest homestead plots, followed by the informal residential area and lastly the RDP residential area. This reflects that the townships are the oldest formal residential areas, with the informal residential areas being intermediate, and the planned low cost RDP residential areas having the smallest. McConnachie and Shackleton (2010) found that the township homestead plots were larger than the RDP residential area plots. Whilst both are relatively poor, the low cost and mass development model for RDP residential areas has dictated that housing density must be high to help reduce associated infrastructure and bulk supply costs per unit. If there has to be any greening activities, homestead plots should be large enough (Venn and Niemela, 2004). This was echoed by some respondents who bemoaned the limited size of homestead plots, especially that trees were cut to allow for expansion of houses. In addition, others wished that homestead plots were a bit larger so that they could plant more trees. Indeed, the results showed that plot size was a factor determining the number of trees per household; the larger the plot size the higher the number of trees, supporting findings from Bangladesh (Uddin and Hasan, 2001).

It has been alluded to above, that most of the households had trees on their homesteads. The lowest percentage of households with trees was recorded in the RDP residential area in Tzaneen and Bela Bela also the township in Zeerust. The RDP residential areas in Tzaneen and Bela Bela had the lowest percentage of households with trees because they were recently constructed and the residents recently started living in them, whereas the RDP residential area in Zeerust, which was established over ten years ago, had trees on all homesteads. Therefore, it can be predicted that the number of households with trees in these residential areas will also increase with time, except where expansion pressures

result in tree removal, such as in the township in Zeerust. Gangopadhyay and Balooni (2012) revealed that as households acquire more wealth, they cut trees on homesteads. The results of this study are contrary to literature (Barbosa *et al.*, 2007; Zhang *et al.*, 2008), that shows wealthy households typically have more trees.

The highest number of trees was recorded in Tzaneen and the least in Zeerust, a pattern which followed the moisture gradient. The mean number of trees was 7.7 ± 6.1 trees per household, the highest was in Tzaneen and the least in Zeerust while the homesteads in the informal residential area had 9.7 ± 7.6 trees per household, while the RDP area had the least of 6.0 ± 5.4 trees per household. These figures were within the range in rural homesteads of 4-38 trees per household (Paumgarten *et al.*, 2005). The town with the highest rainfall per annum had the highest number of trees and the town with the lowest annual rainfall had the lowest number of trees. The other reason for this could be that Tzaneen had other favourable conditions which promote tree growth. For example, some respondents in Bela Bela complained about poor soil conditions constraining the growth of trees. The soils in Bela Bela and Zeerust crack as they swell and shrink during the wet and dry season (Mucina *et al.*, 2005). Lack of water was the other reason. The informal residential area in Bela Bela and Zeerust did not have piped water, making management of young trees difficult, and stray animals browse the young trees, which was not the case for Tzaneen, because all residential areas had running water and perhaps had better tree management practices. This indicates that the distribution and abundance of trees on homesteads is affected by both micro and macro-environmental conditions (Uddin and Hasan, 2001). Some of the solutions to these constraints may include transplanting young trees during the rainy season for residential areas without running water; stray animals can be kept from browsing the young trees by fencing them (this was observed by some households in Tzaneen who had put barriers around the small trees), while soil fertility can be improved by adding organic fertilizer (such as cow dung, chicken and compost manure) before planting trees. The RDP residential areas had more trees which were not taller than 40 cm, since the residential areas had just been developed. It can be expected that after five years or so the small trees will mature and these residential areas will be leafier. The low number of mature trees results in few consumptive and non-consumptive products for urban residents in the RDP area. Similar to abundance of trees, tree density was high in the high rainfall town but the pattern was broken in Bela Bela and Zeerust. Households had tree densities ranging between 35.3 ± 7 and 59.3 ± 16.2 trees per ha in Tzaneen. Tree density was also within the range reported by Paumgarten *et al.* (2005). They reported that tree density ranged between 24 and 198 trees per ha. Villages in Limpopo Province had more trees and higher tree density than the results in this study but were higher than the mean number of trees per household and tree density in the four villages in the Eastern Cape. In all residential areas, there were a lot of trees with a circumference of less than 25 cm, showing that most trees were recently established. This is similar to findings by Paumgarten *et al.* (2005) that trees on rural homesteads were made up of a majority of recently planted trees. There were a few trees of

large circumference, the informal residential area in Tzaneen and Zeerust and the township in Bela Bela had the biggest trees. Trees with big circumference in informal residential areas were not planted but, retained by residents, while the township in Bela Bela had the biggest trees because the residential area is very old (Appendix 2). Since all townships were relatively older than the other two residential areas, all had larger mean tree circumferences. However, the number of years that the rural household head had lived on the homestead had no effect on tree size (Shackleton *et al.*, 2008).

Tree species richness was highest in Bela Bela, followed by Zeerust then Tzaneen. More than half of the total number of trees in Tzaneen were *M. indica*, while Bela Bela and Zeerust had several tree species per household. Hence, high abundance of trees does not indicate high tree species richness. This was due to preference by households favouring more than one tree species (Uddin and Hasan, 2001). Consequently, residents in Bela Bela and Zeerust collect different types of tree products from their homesteads while their Tzaneen counterparts are restricted to fewer types of tree products. If the dominant tree species in a particular year fails to produce, for example one kind of fruit tree species, then the residents would be more vulnerable compared to those residents with different kinds of fruits on their homesteads (Chirwa *et al.*, 2008; Khumalo *et al.*, 2012). In case of tree crop failure, e.g. insect or disease attack on *M. indica*, residents in Tzaneen would be more vulnerable than those in the other towns. Thus, there is need to encourage household owners to plant a diversity of tree species in order to reduce such risks (Stoffberg *et al.*, 2010). Within towns the informal residential areas in Tzaneen, and the township in Bela Bela and Zeerust had the highest number of species per household. It was evident that homesteads with larger homestead plots had more species per household, corroborating work in Niger by Bernholt *et al.* (2009) who showed that larger homestead plots had higher species richness and tree density than smaller ones. Similarly, rural households with larger homestead plots had higher species richness (Paumgarten *et al.*, 2005).

The majority of trees on homesteads were planted, followed by those which had been retained and those which self-seeded. This showed that most of the residents have an interest in planting and maintaining trees on their homesteads. This is contrary to findings by Cilliers *et al.* (2004) who argued that new migrants clear land for housing. It is a misconception therefore to say that people who migrate to urban areas completely clear land to put up their houses. Most urban residents were aware of the contribution of trees by retaining trees in their habitats. This is the *in-situ* conservation of trees (Chirwa *et al.*, 2008). Planting material was mostly accessed from own homesteads, friends, family and neighbours. This was an indicator of social capital (Angelsen and Lund, 2011; Scoones, 1998) which urban residents used to acquire planting material rather than spending their cash income on trees. It could also be that planting material is not readily available or it is too expensive hence residents would rather collect than buy. If so, there is need to make the seeds and seedlings affordable to urban residents.

The most common trees were fruit trees. Urban residents appreciate the contribution of fruit trees to their livelihoods; hence they plant more fruit trees than non-fruit trees. Similarly, there are more fruit trees on homesteads in other developing countries than non-fruit trees (Alam and Masum, 2005; Bernholt *et al.*, 2009; Ndaeyo, 2007). Planting fruit trees as well as non-fruit trees can be seen as livelihood strategies which help urban residents escape the effects of shocks and stresses (Kalaba *et al.*, 2009; Meikle *et al.*, 2001). Fruits have the ability to improve the nutrition and health of the people and can also be used to generate income (Shackleton, 2006). The most common fruit tree in Tzaneen was *M. indica* while in Bela Bela and Zeerust was *P. persica*. Chibende (2009) reported that urban residents in Zambia planted more fruit trees than non-fruit trees with a ratio of 3:1 and these were mainly exotic fruit trees.

Trees in Tzaneen and Zeerust were mostly alien tree species; however Bela Bela had more indigenous tree species. Most residents prefer alien tree species over indigenous tree species because they favour conventional fruit species. It was only in the informal residential area in Zeerust that households had more indigenous trees when expressed as the percentage of trees. The high percentage of indigenous tree species was due to the interest by residents to retain indigenous trees when they set up their houses. This is a confirmation of Uddin and Hasan (2001) that residents choose trees which they perceive to meet their needs, for example most households plant trees for fruits. Both rural and urban residents favour alien tree species (Bernholt *et al.*, 2009; Ndaeyo, 2007; Paumgarten *et al.*, 2005). The indigenous trees species that were among the top seven included: *Sclerocarya birrea* subsp. *caffra*, *Ficus* sp. (Feiye), *Acacia* sp. (Mosu), *Ziziphus rivularis*, *Searsia lancea*, *Acacia karroo* and *Acacia tortilis*. Among the alien trees recorded, *T. stans*, *P. guajava*, *L. lucidum* and *J. mimosifolia* which are regarded as invasive in South Africa (Nel *et al.*, 2004). The high number of alien trees can be due to the ease with which alien tree species can be propagated while indigenous trees take many years to break dormancy (Chisha-Kasumu *et al.*, 2007). Hines and Eckman (1993) and Paumgarten *et al.* (2005) reported that rural households also prefer alien tree species to indigenous trees. Contrary to this trend in developing countries, the pattern in developed countries is different. Urban forests in Europe, America and Australia all have more indigenous tree species than alien tree species; with the latter constituting 30-40% (Clement and Moore, 2003; Frank *et al.*, 2006; Pysek, 1998).

5.2 Tree attributes

The tree circumference was closely associated with the type of residential area, with trees in the township being bigger than the ones in the RDP residential area. Negative relationships were recorded for households with higher cash income having less indigenous trees and most big trees were not indigenous. This was typically in the township residential area. Household characteristics such as age and education of the household head did not closely influence the circumference size of trees and whether trees were indigenous or not. The gender of the household head did not have any effect on the

size of the tree circumference. However, it had a weak influence on the density of trees. Contrary to this, Shackleton *et al.* (2008) found that the gender of the household head was linked to the density of trees on homesteads. Others household characteristics which did not have an effect, were the number of years the household head had lived both in the house and town. In addition, cash income neither impacted on the number of trees as well as tree density. On the other hand, the number of trees per household slightly influenced the number of species per household.

Chapter Three

Uses of tree products by urban households in different residential areas

1 Introduction

Trees provide multiple products and services to human beings and the environment. The importance of trees can be expressed in terms of the clear benefits which are accrued to individuals, households, municipalities, nations and the micro and global environment. Furthermore, these benefits have the potential to improve human well-being, enhance urban sustainability and reduce poverty (MEA, 2005; Shackleton, 2006). The dependence of rural households on conventional forests and natural resources in Africa is well known (Kalaba *et al.*, 2009; Lawes *et al.*, 2004; Legwaila *et al.*, 2011). The benefits derived from these resources by households in urban areas are less understood. These can be obtained from trees within urban centres and further afield (Kuchelmeister, 2000; 2001; Shackleton 2006). Even though trees in urban areas supply similar benefits as in rural areas, there is inadequate information on the collection and use of tree products by urban populations. Some authors (Bentsen *et al.*, 2010; Kuchelmeister, 1999) have attributed this to perceptions amongst scientists and development agencies in developing countries that urban forestry is a young science and its contribution to livelihoods is perceived to be insignificant. Consequently, little is known about the tree products, or the different sources and strategies that urban households use.

Urban forests are made up of various sub-components, including trees on homesteads, parks, street trees and those on the edges of towns (Fuwape and Onyekwelu, 2011; Horst, 2006). The few studies to date in this field have shown that urban forests contribute to the livelihoods of urban residents through the provision of consumptive and non-consumptive tree products. Among the consumptive products that trees in urban areas provide include fruits, fuelwood (Horst, 2006; Kuchelmeister, 2000; 2001), wood for building and fencing, and medicines (Fuwape and Onyekwelu, 2011; Kuchelmeister, 2000; Uddin, 2006). Non-consumptive tree products include carbon sequestration, watershed and soil protection, habitat protection, noise and air pollution reduction, beauty and shade (Horst, 2006), control of water runoff, recreation, temperature buffering, energy conservation and water quality improvement (Shackleton, 2006). Consumptive tree products can be used on a day to day basis within households as well as during the time of livelihood shocks (Shackleton and Shackleton, 2004). Additionally, consumptive tree products can bring direct income into the household through trade in such products (Kalaba *et al.*, 2009; McConnachie *et al.*, 2008; Murwendo, 2011) and indirectly by cash saving through the supply of free tree products (Delang, 2006; Murwendo, 2011).

1.1 Consumptive tree products

1.1.1 Fuelwood

Fuelwood is the primary source of energy in many developing countries, especially in Africa (Kuchelmeister, 2000; 2001; MEA, 2005). Most households (25-90%) in both rural and urban areas in Africa rely on fuelwood for energy (Kuchelmeister, 2001; Malimbwi *et al.*, 2010; MEA, 2005). African countries with large forest (dry forests) cover record the highest percentage of households using fuelwood (Malimbwi *et al.*, 2010). Hence, collection and use of fuelwood also depends on the abundance of trees and this can account for the variations from region to region and within regions. In Nigeria, 97% of urban households buy fuelwood while 3% collect for themselves (Malimbwi *et al.*, 2010). The MEA (2005) estimated that between 25% and 50% of urban households in South Africa use fuelwood. This, however, differs from town to town and from season to season, with residents in small towns having a higher consumption of fuelwood (Shackleton *et al.*, 2007). Davenport *et al.* (2011) reported high percentages of urban households collecting fuelwood, ranging between 65% and 91% in Eastern Cape. However, this differed from McConnachie *et al.* (2008) who reported lower figures in the same region. In regard to seasons, households collect more in winter (four times per week) than summer (once per week) (Shackleton *et al.*, 2007). Fuelwood is mainly used for cooking and heating because it is affordable, available throughout the year (Kalaba *et al.*, 2009) and does not need the use of expensive appliances (Malimbwi *et al.*, 2010; Openshaw, 2010; Shackleton *et al.*, 2007). Fuelwood is a source of energy for poor people who cannot afford to pay for electricity and the electrical appliances. Poorer urban households collect fuelwood from trees within town (Fuwape and Onyekwelu, 2011; Uddin, 2006) and edges of towns (Davenport *et al.*, 2011; Murwendo, 2011). According to Kammen and Lew (2005), in the past two decades the use and collection of fuelwood increased by one-third in African urban areas. This is because urbanisation is taking place at a higher rate than industrial development, resulting in high unemployment levels and reliance on forests for energy (Malimbwi *et al.*, 2010).

Much collection of fuelwood is gender based, mainly by women and children (Uddin, 2006; UNDP, 1997) from street trees (Fuwape and Onyekwelu, 2011), parks (Uddin, 2006), and the edges of towns (Fuwape and Onyekwelu, 2011; Murwendo, 2011; Uddin, 2006). In Malawi, most (90%) of the fuelwood consumed in urban areas come from neighbouring rural lands while 10% is sourced from urban forests, such as street trees, parks and homesteads (Openshaw, 2010). This suggests that urban trees are not the only source of fuelwood because they cannot satisfy the demand. Thus, urban trees typically supplement fuelwood from other sources. According to Shackleton *et al.* (2007), poorer households collect for themselves while their richer counterparts source the commodity by buying from traders and vendors. Similarly, Davenport *et al.* (2011) reported that poorer urban households were the ones collecting fuelwood from the municipal commonage.

1.1.2 Fruits

The global increase in the urban poor may result in more malnourished and food insecure households in urban areas than in rural areas (Baker, 2008; Kuchelmeister, 1999; WRI, 1996). Some rural households, who are mostly poor, face food shortages between the planting and harvesting seasons (Kalaba *et al.*, 2009). Similarly, poor people in urban areas (particularly recent migrants) may experience the same food shortages in this season as well as other seasons. The low asset base of rural households makes them more vulnerable to shocks, compelling them to migrate to urban areas in search of better livelihoods. But many make use of trees and tree products near them. Chibende (2009) found that most tenants in Luanshya (Zambia) planted trees that provide fruits with the ratio of fruit trees to ornamental trees being 3:1. Similar findings have been reported in West Africa (Fuwape and Onyekwelu, 2011). Uddin (2006) advised that fruit tree species should be prioritised during selection of trees for urban forests.

Fruits from trees grown in urban areas serve as an immediate source of food and can improve food security of urban households (Frank *et al.*, 2011; Fuwape and Onyekwelu, 2011; Uddin, 2006). Indigenous fruits most frequently used in southern Africa include *Uapaca kirkiana*, *Anisophyllea boehmii*, *Parinari curatellifolia*, *Strychnos coccouloides*, *Flacourtia indica*, *Diospyros mespiliformis*, *Azanza garkceana*, *Hyphaene thebaica*, *Balanites aegyptiaca*, *Borassus aethiopum*, *Tamarindus indica*, *Adansonia digitata* and *Sclerocarya birrea* (Kalaba *et al.*, 2009; Shackleton and Shackleton 2004; Shackleton *et al.*, 2010). According to Kuchelmeister (2000) the main streets in New Guinea are lined with indigenous fruit trees such as *Terminalia catappa* and *Ceiba pentandra*. However, the number of edible fruits is not restricted to the above stated species, there are other species which have been reported to be edible but rarely used and the information on them is limited (Shackleton *et al.*, 2010).

In contrast to indigenous fruits, alien fruit trees form the majority of trees in both rural (Paumgarten *et al.*, 2005) and urban (Bernholt *et al.*, 2009; Long and Nair, 1999; Uddin and Hasan, 2001) homesteads. The dominant fruit trees among others include *Psidium guajava*, *Mangifera indica* and *Carica papaya* (Alam and Masum, 2005; Ndaeyo, 2007; Winklerprins and de Souza, 2005). Examples from Togo (Raoufou *et al.*, 2011) and New Guinea (Kuchelmeister, 2000) show that *Citrus sinensis*, *C. limon*, *M. indica*, *Artocarpus altilis*, *Coccoloba uvifera*, *C. nucifera*, *Cocos nucifera* are the other common alien fruit trees in urban areas.

Both indigenous and alien fruits can either be consumed in their raw form or processed into other products. Improving the value of fruits by processing them into juices, porridges and jams can help preserve fruits and also make them more palatable, especially indigenous fruits (Kalaba *et al.*, 2009)

and reduce the vulnerability of households which depend on fruits in off-season (Shackleton *et al.*, 2010).

1.1.3 Wood for building, fencing and household tools

Some households in urban areas cannot afford commercially grown timber for building. Households in informal residential areas in West Africa collect wood for building from street trees (Fuwape and Onyekwelu, 2011). Besides, an adequate supply of wood for building is a challenge due to high urbanisation rates (Kuchelmeister, 2000). Similarly, Uddin (2006) reported that wood for building was sourced from trees within urban areas and outside by poorer households to construct their own houses. Murwendo (2011) noted similar trends in Zimbabwe where urban residents were collecting wood from the edges of towns for building. According to Davenport *et al.* (2011), approximately 29% of households in townships in the Eastern Cape province, use wood to make fences, axe and hoe handles, walking and fighting sticks, whereas Cocks (2006) found closer to 50% doing so.

1.1.4 Medicines

Herbal medicines are used around the world by both rural and urban households to meet health care needs (MEA, 2005; Motlhanka and Makhabu, 2011). Medicinal plants are planted in urban forests to supply herbal medicines (Fuwape and Onyekwelu, 2011). These tree products can be collected by users themselves, from traditional healers or bought from traders (Shackleton *et al.*, 2010). The majority of collectors are from rural households (Shackleton and Shackleton, 2004) and the tree parts that are used are usually roots, leaves and bark (Kalaba *et al.*, 2009), and to a lesser extent wood, flowers, fruits, seeds and latex (Shackleton *et al.*, 2010). Trees with medicinal properties include urban trees, such as *Azadirachta indica* together with other species planted in residential areas (Uddin, 2006). According to Cocks and Dold (2006) the use of herbal medicines is often practiced by urbanising households.

It is evident from the literature reviewed that urban trees provide a wide range of consumptive tree products, despite their contribution to local livelihoods being overlooked by government planners, and research agencies. There is a lack of empirical evidence to show the kind of trees used by urban residents in South Africa and how it varies in relation to residency and relative wealth. This chapter explores the consumptive tree products that are collected from trees on homesteads, other places and the edges of towns. It specifically addressed the key question of “What are the tree products that urban households collect and use from trees on homesteads, other places and buy from traders?”

2 Methods

Selection of sample households within each town was carried out using aerial photographs (scale: 1: 5 000). The surface area of each town was divided into three residential areas, i.e., the township, RDP and informal residential areas, facilitating a stratified sampling approach. Residential area boundaries were defined, which were then used to select a random sample in Microsoft Excel. The sample size was 450 households, 150 households from each town and 50 from each urban residential area.

The initial plans were to conduct the study in four types of residential areas, however only three were studied because the affluent residential areas were not easy to access due to high security and most of the households in the affluent residential were not willing to participate. I tried to distribute an information brochure for the project but to no avail, I also contacted a security firm for assistance in supplying client telephone numbers but this also failed. Therefore, the affluent residential area was excluded.

A structured interview schedule (Appendix 1) with both open ended and closed ended questions was formulated. According to Burton (2000) and Wheater and Cook (2000) open ended questions allow the respondent to answer freely without restrictions, while closed ended questions limits the respondent. Hence, the discussion is controlled by the interviewer, who asks for specific data (Allison *et al.*, 1996). Preceding data collection, a pilot study was conducted in Grahamstown in two residential areas, the informal residential area and township. The time it took to finish each interview was determined and unclear questions were noted and revised before printing the interview sheets. The interview schedule had four sections. The first section had questions on the trees and tree products that are collected on the respondent's homestead, the second was on the trees and tree products that are collected from other places (neighbourhood, within town, edges of towns and beyond edges of towns), the third section looked at the tree products bought from traders and supermarkets and the fourth section had questions on the household profile.

The household head was interviewed if present, but where absent, any adult member of the family was interviewed; the interviewees were encouraged to ask other family members when answering some questions related to costs and quantities of different tree products. Data collection included weekends and public holidays to accommodate people who work. If nobody was present at a selected household, or if the household head refused to be interviewed, the next randomly selected household on the sample frame was interviewed. Interviews were conducted in English or translated into a preferred local language. Each interview lasted approximately one hour.

All interviews were complemented by observations and notes. Observations are an important tool for data collection as they aim at recording, analysing and interpreting behaviour and actions of a subject

of interest (Ritchie, 2003). Observations provide the opportunity to check and corroborate data collected from other research methods (Foster, 1996) and allow the researcher to scrutinise what is happening in real life situations (Denscombe, 2007). In addition, observations enable the researcher to check if the questions are correctly answered (Angelsen and Lund, 2011). Consequently, note taking was another method of data collection; it is a non-verbal method of data collection (Neuman, 2003). Furthermore, note taking enables the researcher to understand the behaviour of respondents and their level of agreement (e.g. head shaking).

3 Data analysis

Prior to data analysis, the answers to the structured interview schedule were coded. Coding is the process by which interviewees' responses are transformed (e.g. open or closed ended questions) into numbers or letters. This process is important in research surveys as it facilitates numeric data analysis (Neuman, 2003). Coded qualitative and quantitative data were entered into Microsoft Excel. The qualitative and quantitative data were analysed using Statistica 10. Descriptive statistics such as bar graphs, histograms, frequency tables and percentages were created. Initial data exploration via principle components analysis (PCA) was used to portray the relationships between household data and data on collection and buying of tree products. For normally distributed data, a two-way ANOVA was used to analyse continuous data and compare town and suburbs simultaneously, however a non-parametric test (Kruskal-Wallis test) was used for data which were not normally distributed, Spearman rank order correlation was used to see if there were associations between household data (age, education) and how often households collect tree products per month. In all analyses a significance level of 5% was applied.

4 Results

Tree products were very important in the livelihoods of the people in the sampled urban areas. However, the rate at which they were collected and what was collected differed from town to town and from one residential area to another. There were numerous tree products used by urban households which were accessed from different sources and procured in many ways. Tree products were classified into two groups, major and minor tree products depending on the number of times a particular tree product was collected or bought per month. Major tree products were collected or bought at least once per month, and included fuelwood and fruits, while minor tree products comprised wood for building and fencing, herbal medicines, propagation material, mulch, compost, seed pods for decoration and household utensils fall within the minor category were all procured less than once per month.

4.1 Major tree products

4.1.1 Fuelwood collected on homesteads

Thirty-three percent of households collected fuelwood on their own homesteads. Across towns, Tzaneen had slightly below half (48%), followed by Bela Bela (30.7%) and then Zeerust (22.7%) (Figure 3.1). Considering residential areas, the township recorded the greatest percentage (45.3%) of households collecting fuelwood from homesteads, followed by the informal residential area and then the RDP areas. Even though households collected fuelwood from homesteads, the frequency at which they collected the product was low compared to fuelwood collected from other places and bought from traders. Households did not collect from homesteads every month except in the informal residential area in Tzaneen (Table 3.1). Households in Tzaneen collected fuelwood from homesteads significantly ($H = 17.1$; $p = 0.02$) more frequently than in Bela Bela and Zeerust.

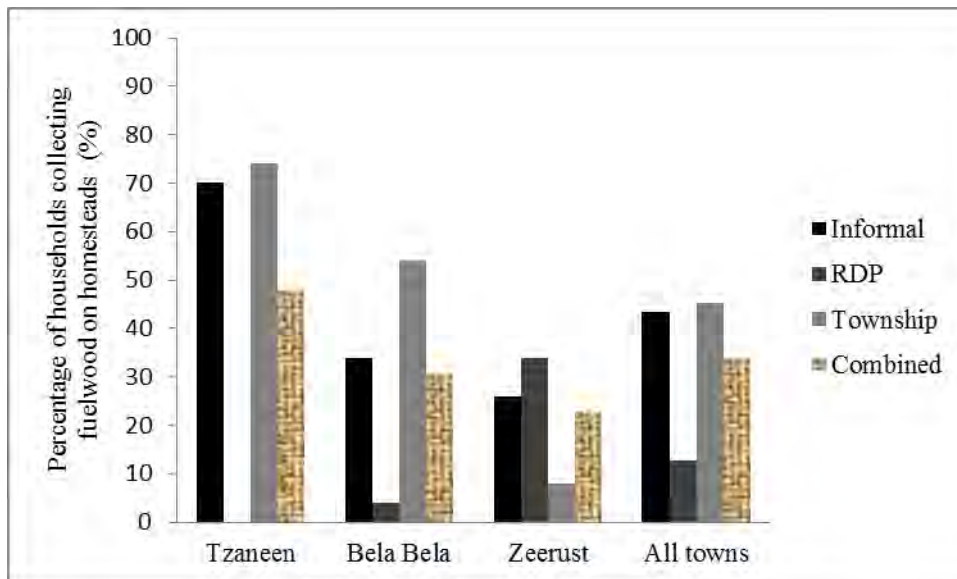


Figure 3.1: Percentage of households collecting fuelwood on their homesteads

4.1.2 Fuelwood collected from other places

The edges of towns proved to be an important source of fuelwood for many households, especially those without electricity. All households in the RDP area in Tzaneen and the informal residential area in Bela Bela and Zeerust did not have electricity supply. In addition, households with low cash income (Chapter 4) collected more fuelwood from the surrounding places.

There were more households in all towns (42.2%) which collected fuelwood from other places than from homesteads. Zeerust recorded the highest percentage (60%) of households collecting fuelwood from other places, followed by Bela Bela and lastly Tzaneen (24.7%). Across residential areas, the

residents of informal areas were the major (60%) collectors of fuelwood from other places, the RDP area was intermediate and the township was the least (Figure 3.2).

Table 3.1: Mean (\pm sd) frequency for fuelwood collection and buying per month (Comparing towns, unlike superscripts represent significant differences within columns. Note: Seasonality was not considered for fuelwood collected from trees on homesteads because the products were collected mainly once in a year. Where there is * statistical test was not applicable because of low sample size)

Towns	Residential area	Source of fuelwood				
		Homesteads	Other places		Bought	
		Year	Summer	Winter	Summer	Winter
Tzaneen	Informal	1.1 \pm 5.1 ^a	5.1 \pm 6.4 ^a	10.1 \pm 18.4 ^a	1.4 \pm 1.3 ^a	1.5 \pm 1.7 ^a
	RDP	0 \pm 0*	9.4 \pm 10.8 ^a	9.1 \pm 10.6 ^a	2.3 \pm 3.9 ^a	2.1 \pm 2.1 ^a
	Township	0.3 \pm 0.7 ^a	0.7 \pm 0.5 ^a	1.1 \pm 1.1 ^a	0.9 \pm 0.9 ^a	1.8 \pm 2.5 ^a
Bela Bela	Informal	0.1 \pm 0 ^a	13.5 \pm 10.9 ^b	10.9 \pm 9.8 ^a	1.0 \pm 0.0 ^a	3.7 \pm 4.3 ^a
	RDP	0.2 \pm 0.1*	5.5 \pm 4.5 ^a	7.9 \pm 5.8 ^a	1.1 \pm 1.8 ^a	2.5 \pm 3.3 ^a
	Township	0.2 \pm 0.2 ^a	1.4 \pm 1.0 ^a	3.8 \pm 4.2 ^a	2.2 \pm 4.7 ^a	3.6 \pm 6.5 ^a
Zeerust	Informal	0.1 \pm 0.0 ^a	13.6 \pm 10.0 ^b	18.8 \pm 11.0 ^b	3.0 \pm 3.8 ^a	3.3 \pm 4.1 ^a
	RDP	0.1 \pm 0.1*	8.3 \pm 6.2 ^a	12.9 \pm 9.9 ^a	1.3 \pm 0.6 ^a	2.5 \pm 2.4 ^a
	Township	0.2 \pm 0.1 ^a	5.8 \pm 5.7 ^a	12.2 \pm 7.8 ^b	1.1 \pm 1.5 ^a	4.4 \pm 8.4 ^a

The frequency at which fuelwood was collected varied between seasons. Households collected fuelwood more often in winter than summer. Zeerust and Bela Bela significantly ($H = 9.5$; $p = 0.009$) collected fuelwood more frequently (9.2 ± 7.3 and 6.8 ± 5.5) than Tzaneen in summer, whereas in winter Zeerust significantly ($H = 25.2$; $p = 0.0001$) collected more frequently (14.6 ± 4.4) than Tzaneen (6.8 ± 10.0) and Bela Bela (7.5 ± 6.6). Considering residential areas, the informal residential area in Zeerust and Bela Bela significantly ($H = 11.3$; $p = 0.004$) collected more frequently (13.6 ± 10.0 and 13.5 ± 10.9) than Tzaneen in summer. Similarly, in winter households in Zeerust significantly ($H = 15.7$; $p = 0.0004$) collected more frequently (18.8 ± 11.0) than Bela Bela and Tzaneen. Correspondingly, the township in Zeerust and Bela Bela significantly ($H = 10.4$; $p = 0.005$) collected more frequently (12.2 ± 7.8 and 3.8 ± 4.2) than Tzaneen in winter (Table 3.1).

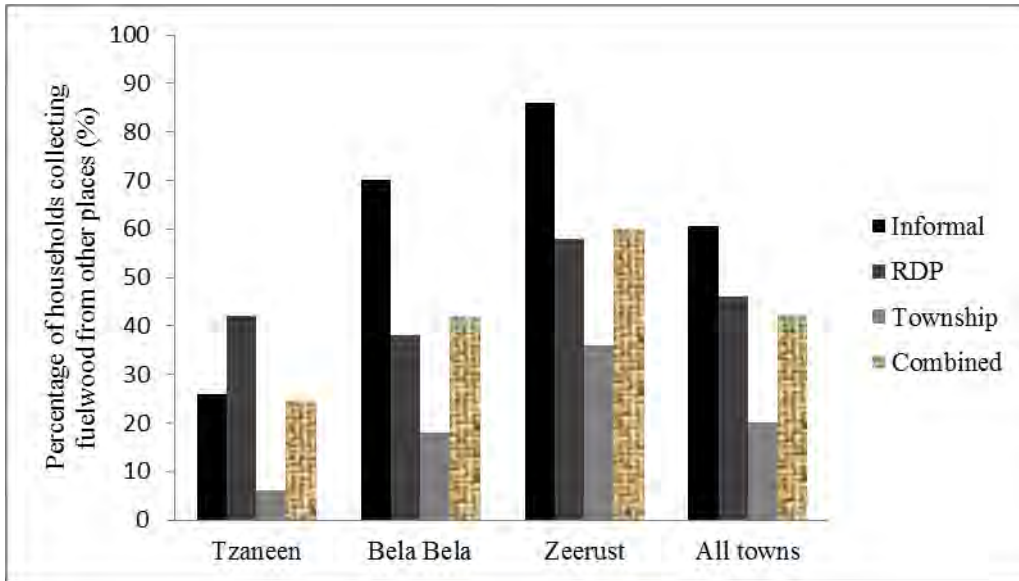


Figure 3.2: Percentage of households collecting fuelwood from other places

Fuelwood was mainly sourced from the edges of towns. On average, 17% of households in Tzaneen, 35% in Bela Bela and 51% in Zeerust collected it from the edges of towns compared to 1%, 5% and 9% who collected from beyond the edges of towns, respectively. Other households collected off-cuts from industrial areas and within towns.

4.1.3 Fuelwood bought from traders and supermarkets

The third source of fuelwood was by buying. Close to half (47.6%) the households bought fuelwood. Among towns, over half (53.3%) of households in Bela Bela bought fuelwood, followed by Tzaneen just below half and then Zeerust with 40.7%. Among residential areas, more (54%) households in the informal residential area bought fuelwood while the township was intermediate and the RDP area had the least proportion of households buying fuelwood (Figure 3.3). Similar to collection, households bought more frequently in winter than in summer. Fuelwood accessed by this method was second to collection from other places and homesteads being the least. There were no significant differences on how frequent households bought fuelwood both among towns and residential areas (Table 3.1).

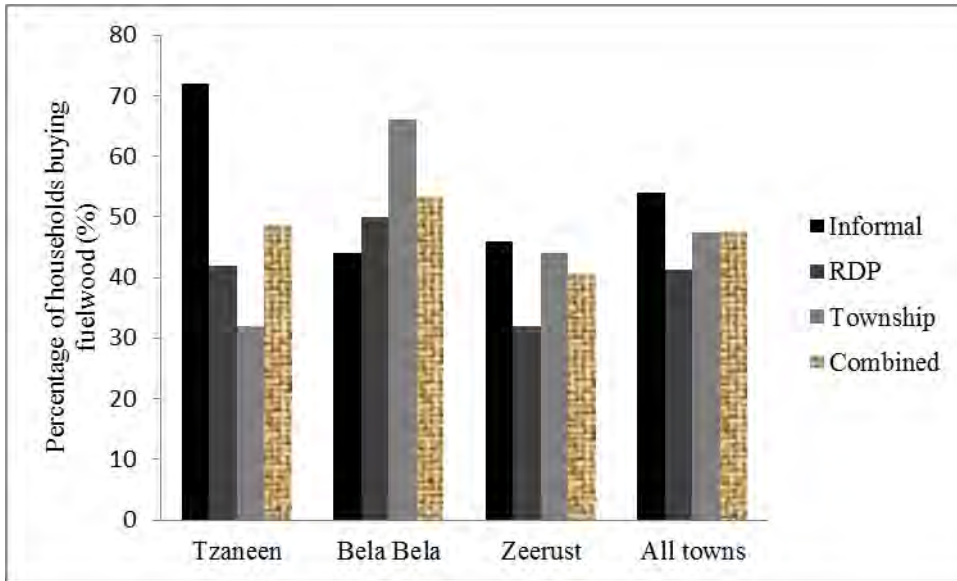


Figure 3.3: Proportion of households buying fuelwood

4.1.4 Fruits collected on homesteads

Almost half (48%) of all households collected fruits from their homesteads. The town with the greatest number of trees (Tzaneen) recorded the highest (64.7%) percentage of households collecting fruits from homesteads, followed by Zeerust (41.3%), despite having the least number of trees, and Bela Bela (38%) (Figure 3.4). Across residential areas, the greatest collection of fruits was recorded in the township, with the least in the RDP area. Tzaneen recorded the highest (21) number of fruit tree species used which in turn was followed by Bela Bela (16) and lastly Zeerust (14).

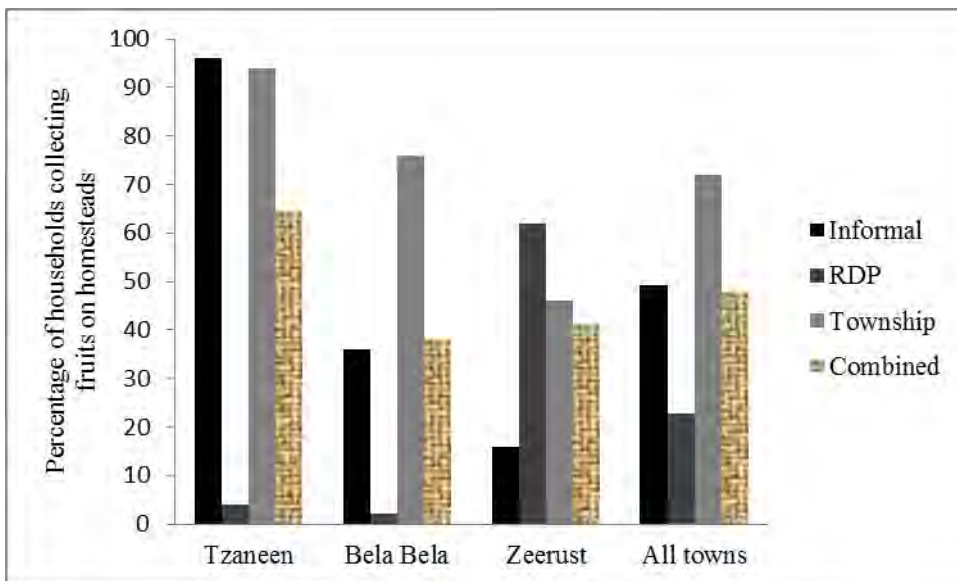


Figure 3.4: Percentage of households collecting fruits on own homesteads

Fruit trees were exploited differently in the three towns depending on the availability of certain tree species. Over 90% of the households in the informal residential area and township in Tzaneen harvested *Mangifera indica* (Table 3.2). Whereas *Prunus persica* was the most commonly collected fruit species by households in Bela Bela and Zeerust. Households in all residential areas that collected fruits from trees on homesteads did so 16-24 times per month, except for the RDP area in Tzaneen (only three times per month) and Bela Bela (daily). In addition, households collected fruits from homesteads more frequently than they collected from other places or bought (Table 3.3 and 3.4), which was typically only once to five times per month.

Table 3.2: Percentage of households collecting the top seven fruit species on own homesteads and mean (\pm sd) frequency per month (Comparing towns, unlike superscripts represent significant differences within columns. Note: * statistical test was not applicable, due to low sample size)

Town	Informal	(%)	RDP	(%)	Township	(%)
Tzaneen	<i>Mangifera indica</i>	96	<i>Carica papaya</i>	2	<i>Mangifera indica</i>	94
	<i>Psidium guajava</i>	16	<i>Psidium guajava</i>	2	<i>Citrus sinensis</i>	30
	<i>Carica papaya</i>	14			<i>Carica papaya</i>	26
	<i>Citrus limon</i>	14			<i>Persea americana</i>	20
	<i>Persea americana</i>	14			<i>Citrus limon</i>	16
	<i>Vitis vinifera</i>	14			<i>Litchi chinensis</i>	12
	<i>Syzygium guineense</i>	12			<i>Vitis vinifera</i>	10
	Mean freq./month	24.6\pm22.9^a		2.7\pm2.4*		16.8\pm14.1^a
Bela Bela	<i>Prunus persica</i>	24	<i>Prunus persica</i>	2	<i>Prunus persica</i>	46
	<i>Morus nigra</i>	14			<i>Citrus limon</i>	32
	<i>Citrus limon</i>	2			<i>Carica papaya</i>	22
	<i>Passiflora edulis.</i>	2			<i>Mangifera indica</i>	20
	<i>Psidium guajava</i>	2			<i>Psidium guajava</i>	20
	<i>Sclerocarya birrea</i>	2			<i>Morus nigra</i>	18
	<i>Vitis vinifera</i>	2			<i>Passiflora edulis.</i>	16
	Mean freq./month	25.5\pm29.9^a		30.5\pm0*		20.2\pm13.4^a
Zeerust	<i>Morus nigra</i>	10	<i>Prunus persica</i>	52	<i>Prunus persica</i>	32
	<i>Prunus persica</i>	4	<i>Passiflora edulis</i>	6	<i>Vitis vinifera</i>	14
	<i>Searsia lancea</i>	4	<i>Malus domestica</i>	4	<i>Ficus sp. (Feiye)</i>	10
	<i>Ziziphus rivularis</i>		<i>Morus nigra</i>	4	<i>Morus nigra</i>	10
			<i>Vitis vinifera</i>	4	<i>Citrus sinensis</i>	6
			<i>Citrus limon</i>	2	<i>Citrus limon</i>	4
			<i>Citrus sinensis</i>	2	<i>Prunus armeniaca</i>	4
	Mean freq./month	21.4\pm13.7^a		23.6\pm13.1		17.3\pm13.1^a

4.1.5 Fruits collected from other places

Fruits were collected from other places including neighbours', friends' and relatives' homesteads for both exotic and indigenous fruit species and wild fruits from the edges of towns. Fewer (33.3%) households collected fruits from other places than homesteads. Over half of the households (55.3%) in Bela Bela collected fruits from other places while Tzaneen was intermediate and Zeerust had the least (11.3%) (Figure 3.5). The highest (40.7%) proportion of households collecting fruits from other places were recorded in the RDP residential area while below one quarter was encountered in the township. The most commonly collected fruits from other places included *Citrus sinensis* and *Carica papaya* in Tzaneen, *P. persica* and *C.sinensis* in Bela Bela and Zeerust (Table 3.3). Similar to the number of fruit tree species used on homesteads, Tzaneen once again recorded the highest number of

fruit tree species collected from other places, followed by Bela Bela and lastly Zeerust with 20, 15 and eight fruit tree species, respectively.

Table 3.3: Percentage of households collecting the top seven fruits from other places and mean (\pm sd) frequency per month (Comparing towns, unlike superscripts represent significant differences within columns. Note * statistical test was not applicable, due to low sample size)

Town	Informal	(%)	RDP	(%)	Township	(%)
Tzaneen	<i>Citrus sinensis</i>	18	<i>Citrus sinensis</i>	18	<i>Citrus sinensis</i>	12
	<i>Malus domestica</i>	16	<i>Carica papaya</i>	16	<i>Litchi chinensis</i>	8
	<i>Mangifera indica</i>	14	<i>Mangifera indica</i>	16	<i>Carica papaya</i>	4
	<i>Carica papaya</i>	10	<i>Persea americana</i>	16	<i>Prunus persica</i>	4
	<i>Litchi chinensis</i>	10	<i>Malus domestica</i>	6	<i>Vitis vinifera</i>	4
	<i>Persea americana</i>	8	<i>Psidium guajava</i>	6	<i>Citrus limon</i>	2
	<i>Pyrus pyrifolia</i>	6	<i>Syzygium guineense</i>	4	<i>Persea americana</i>	2
	Mean freq./month	3.1\pm4.8^a		1.8\pm4.0^a		2.7\pm6.4^a
Bela Bela	<i>Prunus persica</i>	52	<i>Prunus persica</i>	46	<i>Persea americana</i>	28
	<i>Citrus sinensis</i>	44	<i>Citrus limon</i>	32	<i>Citrus sinensis</i>	20
	<i>Citrus limon</i>	30	<i>Mangifera indica</i>	20	<i>Citrus limon</i>	16
	<i>Mangifera indica</i>	20	<i>Citrus sinensis</i>	20	<i>Prunus persica</i>	16
	<i>Psidium guajava</i>	14	<i>Psidium guajava</i>	16	<i>Mangifera indica</i>	6
	<i>Persea americana</i>	12	<i>Persea americana</i>	14	<i>Psidium guajava</i>	6
	<i>Vitis vinifera</i>	12	<i>Carica papaya</i>	10	<i>Carica papaya</i>	4
	Mean freq./month	4.9\pm6.1^b		9.9\pm11.5^b		4.9\pm4.1^b
Zeerust	<i>Prunus persica</i>	4	<i>Prunus persica</i>	24	<i>Citrus sinensis</i>	4
			<i>Citrus sinensis</i>	6	<i>Citrus limon</i>	2
			<i>Citrus limon</i>	4	<i>Searsia lancea</i>	2
			<i>Ficus</i> sp.(Feiye)	4	<i>Vitis vinifera</i>	2
			<i>Pyrus pyrifolia</i>	4		
			<i>Passiflora edulis</i>	2		
	Mean freq./month	13.2\pm0*		6.2\pm10.1^b		9.6\pm11.7^b

In regard to towns, households in Zeerust significantly ($H = 69.0$; $p = 0.002$) collected more frequently (9.7 ± 7.3) than households in Tzaneen, followed by households in Bela Bela significantly ($H = 69.0$; $p = 0.00001$) collecting more frequently (6.6 ± 7.2) than the households in Tzaneen. Considering residential areas, households the informal residential area in Bela Bela significantly ($H = 12.0$; $p = 0.01$) collected more frequently (4.9 ± 6.1) than the ones in Tzaneen. Whereas the RDP area in Bela Bela and Zeerust significantly ($H = 51.4$; $p = 0.00001$) collected more frequently (9.9 ± 11.5 and 6.2 ± 10.1) than Tzaneen. Similarly, the township in Zeerust and Bela Bela significantly collected ($H = 16.0$; $p = 0.0003$) more frequently (4.9 ± 4.1 and 9.6 ± 11.7) than their Tzaneen counterparts.

4.1.6 Fruits bought from traders or supermarkets

In addition to collected fruits on homesteads and other places, households bought fruits from traders and supermarkets in all the towns across all residential areas. At least 90% of households in the three towns bought fruits, the most common being *M. domestica*, *C. sinensis* and *Pyrus pyrifolia*. This was the least used source of acquiring fruits (Table 3.4).

Table 3.4: Percentage of households buying fruits and mean (\pm sd) frequency (Comparing towns, unlike superscripts represent significant differences within columns)

Town	Informal	(%)	RDP	(%)	Township	(%)
Tzaneen	<i>Malus domestica</i>	74	<i>Malus domestica</i>	84	<i>Malus domestica</i>	92
	<i>Pyrus pyrifolia</i>	50	<i>Citrus sinensis</i>	40	<i>Pyrus pyrifolia</i>	42
	<i>Citrus sinensis</i>	44	<i>Pyrus pyrifolia</i>	24	<i>Citrus sinensis</i>	38
	<i>Vitis vinifera</i>	24	<i>Vitis vinifera</i>	12	<i>Vitis vinifera</i>	34
	<i>Persea americana</i>	18	<i>Carica papaya</i>	8	<i>Carica papaya</i>	12
	<i>Carica papaya</i>	12	<i>Persea americana</i>	8	<i>Prunus persica</i>	12
	<i>Litchi chinensis</i>	8	<i>Litchi chinensis</i>	6	<i>Litchi chinensis</i>	22
	Mean freq./month	2.5\pm4.1^a		4.7\pm13.6^a		3.5\pm6.7^a
Bela Bela	<i>Malus domestica</i>	86	<i>Malus domestica</i>	90	<i>Malus domestica</i>	96
	<i>Citrus sinensis</i>	80	<i>Citrus sinensis</i>	72	<i>Citrus sinensis</i>	74
	<i>Pyrus pyrifolia</i>	34	<i>Pyrus pyrifolia</i>	58	<i>Pyrus pyrifolia</i>	52
	<i>Mangifera indica</i>	18	<i>Mangifera indica</i>	48	<i>Mangifera indica</i>	24
	<i>Vitis vinifera</i>	18	<i>Prunus persica</i>	26	<i>Vitis vinifera</i>	18
	<i>Persea americana</i>	6	<i>Persea americana</i>	22	<i>Persea americana</i>	14
	<i>Prunus persica</i>	4	<i>Vitis vinifera</i>	10	<i>Carica papaya</i>	12
	Mean freq./month	5.4\pm9.2^b		5.0\pm5.8^a		4.1\pm3.7^b
Zeerust	<i>Malus domestica</i>	96	<i>Malus domestica</i>	92	<i>Malus domestica</i>	96
	<i>Citrus sinensis</i>	78	<i>Citrus sinensis</i>	78	<i>Citrus sinensis</i>	48
	<i>Pyrus pyrifolia</i>	42	<i>Pyrus pyrifolia</i>	48	<i>Pyrus pyrifolia</i>	38
	<i>Prunus persica</i>	24	<i>Vitis vinifera</i>	18	<i>Prunus persica</i>	26
	<i>Mangifera indica</i>	12	<i>Prunus persica</i>	14	<i>Vitis vinifera</i>	20
	<i>Vitis vinifera</i>	6	<i>Prunus persica</i>	14	<i>Mangifera indica</i>	18
				12	<i>Persea americana</i>	6
	Mean freq./month	1.8\pm3.7^c		1.9\pm4.5^b		2.1\pm4.5^a

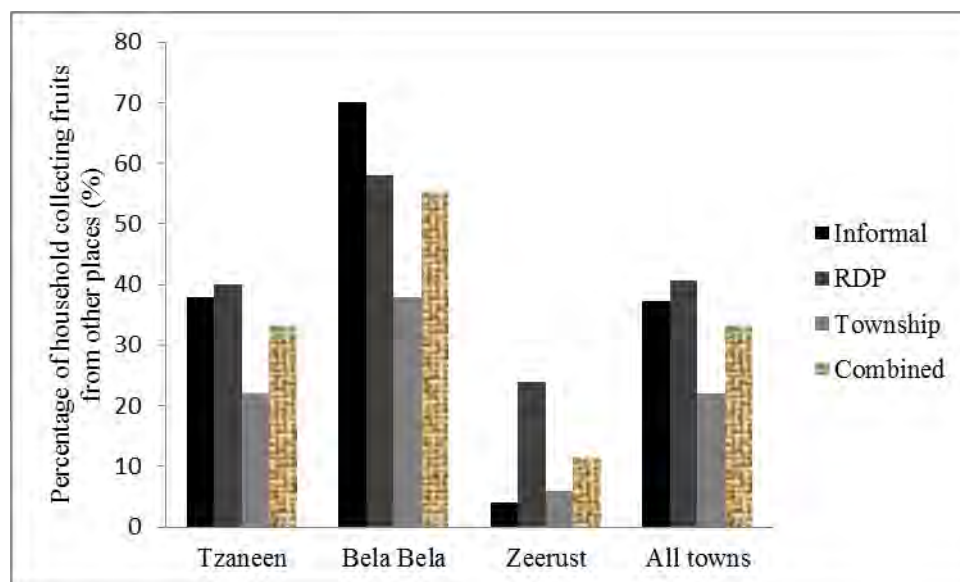


Figure 3.5: Percentage of households collecting fruits from other places

4.2. Minor tree products

4.2.1 Wood for building

A few households collected wood for building from their homesteads; eight percent of the households in the informal residential area in Tzaneen had collected wood to construct or repair their houses. This was the only residential area where households used trees on homesteads to serve as building material (Table 3.5). The wood for building was also sourced from the edges of towns and beyond. Tzaneen recorded the lowest percentage of households collecting wood for building, then Bela Bela in the middle and Zeerust had the highest (30.7%) (Table 3.5). Across residential areas, households in the informal residential areas were the highest collectors and the township was the least (4%). These products were collected between two and five years ago and the mean number of poles ranged between 11 and 16 poles (Table 3.6). This was the second most important way of accessing wood for building. Like fuelwood, wood for building was mostly collected from the edges of towns. On average, two percent of households in Tzaneen collected from the edges of town and no household collected from beyond. Similarly, in Bela Bela, 3% and 1% collected from edges of town and beyond, respectively. On a contrary, a higher proportion (16%) of households in Zeerust collected from places beyond the edges of town than 14% of households which collected from the edges of town.

Most households (52.4%) accessed wood for building by buying. Sixty-one percent of the households in Bela Bela bought wood for building followed by Zeerust and then Tzaneen (44.7%) (Table 3.5). Among the residential areas, the informal residential area was the greatest buyer of wood for building and the least was the RDP. Wood for building was, on average, bought over a year and half (± 0.7) years back and the mean number of poles bought ranged between 7.4 ± 3.0 to 16.1 ± 11.8 poles (Table 3.6).

4.2.2 Wood for fencing

Relatively few households collected wood for fencing. Considering the three sources, there was no source which exceeded a quarter of households sampled. On homesteads, Tzaneen recorded the highest percentage of households collecting wood for fencing (Table 3.5), while from other places and buying, it recorded the least, whereas more households in Zeerust were collecting from other places (Table 3.5), while households in Bela Bela bought more (Table 3.5). In regard to residential areas, more households in the informal residential areas were collecting wood for fencing from trees on homesteads, other places as well as buying. Wood for fencing was also collected from trees on the edges of towns. More households were collecting wood for fencing on the edges than beyond the edges of towns, for example, 5%, 12% and 35% of households were collecting wood for fencing on the edges of town in Tzaneen, Bela Bela and Zeerust, respectively. It was also observed that some

households planted trees along the yard, playing the role of live fence and acting as wind breaks. The tree species used for these purposes were *Dodonaea viscosa*, *Tecoma stans* and *Ligustrum lucidum*.

Table 3.5: The percentage (%) of households collecting and buying minor tree products on own homesteads, other places and supermarkets/traders

Town	Tree products	Homesteads			Other places			Buying		
		Informal	RDP	Township	Informal	RDP	Township	Informal	RDP	Township
Tzaneen	Compost	20	0	24	0	0	0	0	0	0
	Flowers	0	0	2	0	0	2	0	0	0
	Herbal medicines	24	2	14	4	6	4	6	0	8
	Household utensils	6	0	0	4	0	0	86	92	98
	Mulch	30	0	20	0	0	0	0	0	0
	Planting material	60	2	36	34	16	4	34	6	16
	Seed pods	0	0	0	0	0	0	0	0	0
	Wood for building	8	0	2	4	0	0	92	0	42
Bela Bela	Wood for fencing	30	0	0	16	0	0	36	0	0
	Compost	12	0	0	6	4	0	0	0	0
	Flowers	0	0	0	0	0	2	0	0	0
	Herbal medicines	8	0	14	24	20	6	0	16	12
	Household utensils	0	0	0	4	0	0	84	94	96
	Mulch	6	0	0	10	4	0	0	0	0
	Planting material	4	0	0	14	22	4	0	14	10
	Seed pods	0	0	0	0	4	0	0	0	0
Zeerust	Wood for building	0	0	0	12	0	0	88	28	68
	Wood for fencing	0	6	8	28	22	18	38	36	10
	Compost	4	6	0	0	0	0	0	0	0
	Flowers	0	0	0	0	0	0	0	0	0
	Herbal medicines	0	0	4	14	6	8	28	0	0
	Household utensils	0	0	0	0	0	0	46	42	68
	Mulch	0	0	0	0	0	0	0	0	0
	Planting material	0	0	0	58	18	0	4	0	0
Seed pods	0	0	0	0	4	0	0	0	0	
Wood for building	0	0	0	56	24	12	64	42	48	
Wood for fencing	4	4	4	88	54	18	20	20	18	

4.2.3 Herbal medicines

Very few (less than 10 %) households collected herbal medicines from homesteads (Table 3.5). The tree species used were *C.limon*, *M. indica*, *P. guajava*, *S. guineense* and *S. birrea*. Households in Tzaneen followed by Bela Bela were the major collectors. Households in the informal residential area collected and bought herbal medicines more than in the RDP area and township (Table 3.5).

4.2.4 Other minor tree products

Other minor tree products which were used by very few households included planting material, mulch, compost, seed pods for decoration and household utensils. Planting material was collected by less than 20 % of the sampled households. Tzaneen had the largest percentage of households collecting planting material from trees on homesteads (Table 3.5). Other details on the percentage of households collecting and buying various minor tree products are presented in Table 3.5.

Table 3.6: The mean (\pm sd) frequency and quantity of households collecting and buying wood for building (Comparing towns, unlike superscripts represent significant differences within columns. Note: Statistical test not applicable to the RDP and township residential areas due missing figures)

Town	Residential area	Collected		Bought	
		Last collected (years)	Quantity (poles)	Last bought (years)	Quantity (poles)
Tzaneen	Informal	2 \pm 0.0	13 \pm 9.9	1.8 \pm 1.2 ^a	14.5 \pm 12.5 ^a
	RDP	0	0	0	0
	Township	0	0	0	0
Bela Bela	Informal	1.8 \pm 1.0	11.2 \pm 8.5	2.4 \pm 1.9 ^b	9.4 \pm 5.8 ^a
	RDP	0	0	1.5 \pm 0.7	10.7 \pm 6.4
	Township	0	0	3.9 \pm 6.5	7.4 \pm 3.0
Zeerust	Informal	3.9 \pm 2.2	14.6 \pm 11.0	3.3 \pm 2.5 ^b	16.1 \pm 11.8 ^a
	RDP	4.9 \pm 3.5	10.5 \pm 9.9	5.0 \pm 4.0	9.8 \pm 6.3
	Township	5.2 \pm 7.2	15.4 \pm 14.8	6.1 \pm 6.1	13.9 \pm 8.7

4.2.5 Household attributes influencing the use of tree products

The PCA results showed that total household cash income negatively influenced the collection of fuelwood, wood for building and fencing from other places (Figure 3.6). Households which earned higher cash incomes were not collecting tree products from other places compared to those who earned less. However, household characteristics such as gender, age of the household head and the number of years the household head has lived in the house or town, did not have any influence on collecting tree products from other places. Similarly, there was no association between collection of tree products on own homesteads and purchasing from traders and supermarkets and other household data. The first principle component accounted for 20.3% of the variance and the second axis for 15.7%.

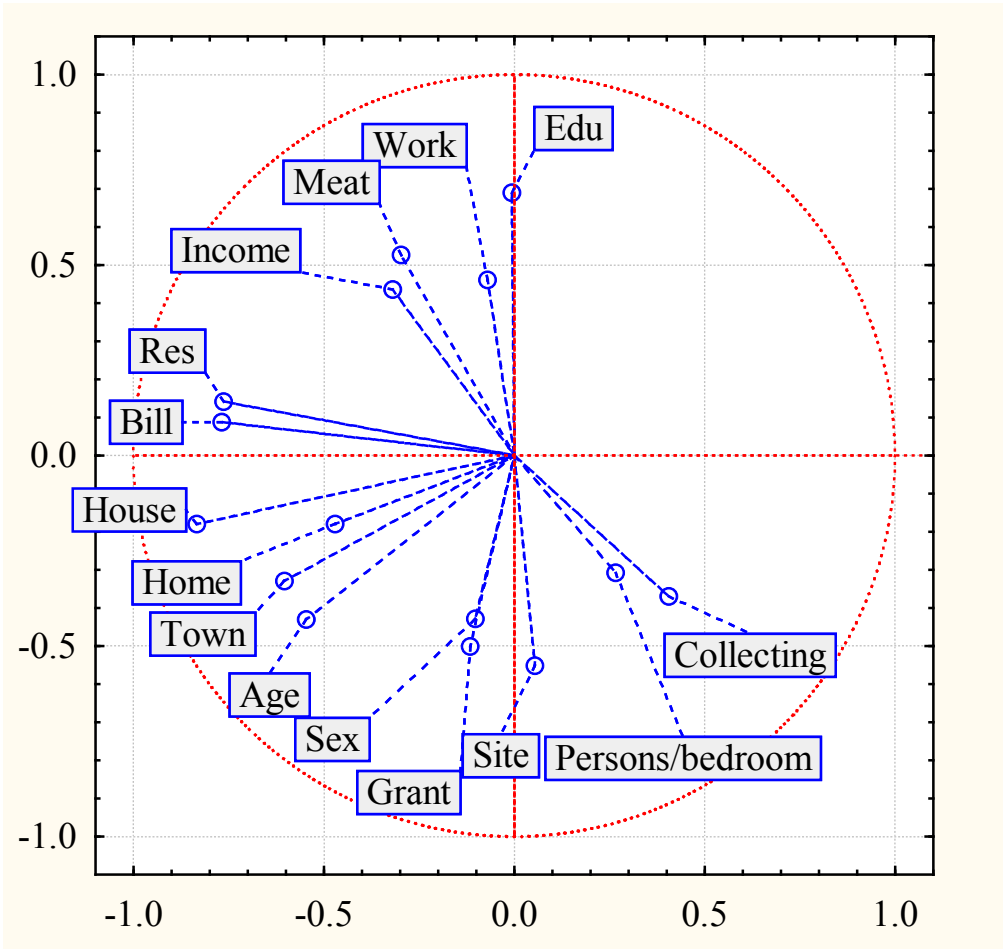


Figure 3.6: PCA vector plot for collecting tree products and household attributes (Axis 1 = 20.3% of variance; Axis 2 = 15.7%)

5 Discussion

It was evident that trees from urban forests were important to the livelihoods of people in the sampled towns and residential areas. Urban residents collected various consumptive tree products, including fruits, fuelwood, wood for building and fencing, planting material, herbal medicines, seed pods for decoration, mulch and compost. A report from Bangladesh (Uddin and Hasan, 2001) showed that households were collecting similar tree products on their homesteads. In addition, in Masvingo City (Zimbabwe), urban residents also collect various tree products such fuelwood, herbal medicines, wood for building and fruits from the edges of town (Murwendo, 2011). Most of these were available throughout the year, but some were seasonal. Considering all households in this study, collection of tree products on own homesteads ranged between 5%-48%, while from other places, 1% to 53% and buying ranged between 0% and 90%. These proportions are similar to urban households (27% to 70%) in the Eastern Cape province which were collecting tree products from places around small towns (Davenport *et al.*, 2011). However, these are lower than in rural situations. For example Shackleton and Shackleton (2004) found that more than 85% of rural households collect tree products from the natural vegetation, similarly almost all (97%) Zambian rural households collect indigenous fruits (Kalaba *et al.*, 2009). Generally, more households with lower income were collecting tree products (fuelwood, wood for building and fencing) than those which earned higher income. This did not apply to fruits. It must be noted, however, that there were variations between towns, residential areas and residential areas within towns. Other households were accessing tree products by buying. Tree products accessed through this method could be collected from either urban forests or conventional forests (Openshaw, 2010).

The sample design of the study stratified each town into areas of differing socio-economic status and probable length of stay. The informal residential area is the poorest, is home to new urban migrants, and most lack urban services such as electricity and water. Thus, I hypothesised that they would have a higher use of trees and tree products, the bulk of which would be sourced from the edges of towns. The RDP residential areas are also home to mostly the urban poor (municipalities must maintain list of who qualifies, based on an indigence test). These centrally planned and laid out areas were first built in the early 1990s, which means most of the trees on homesteads would be relatively young (Chapter 2). In contrast to these two, the township residential area is much older and is characterised by households with relatively higher cash incomes.

In exploring patterns between towns (along a rainfall gradient) and within towns (by residential area) several differences were evident. At the inter-town scale, Tzaneen, the moistest site, had a higher density and species richness trees (Chapter 2). This translated in a higher proportion of households using fruits and fuelwood as well as all the minor products from their own homesteads than the other two towns. However, the pattern was not consistent between Bela Bela and Zeerust; some results

showed tree use to be more prevalent at Bela Bela and other results showed Zeerust to be higher than Bela Bela. The difference in rainfall between these two is relatively small and a lot less than the difference between them and Tzaneen. These results suggest that the ecological setting has an influence on the use of tree products, through its effect on actual abundance and species richness of trees available to residents. This is discussed in more detail under each product type.

Analysis of intra-town patterns of trees use also revealed some interesting trends. Fruit harvesting from resident's own homesteads was most frequent in the township residential areas. These households were least likely to collect wild fruits from other places. A similar pattern was observed for fuelwood, with more township households collecting fuelwood from their own homestead (and least from other places) than residents of the RDP or informal areas. Both of these findings are not unexpected because township households had larger plots and were more established and therefore they had more trees from which to harvest or collect such products. Interestingly though, the proportion of township residents using minor products was often lower than the RDP and informal residential areas. I suggest that this might be a reflection of their relatively higher income and education and therefore many of them have substituted such minor tree products with alternatives. For example, they have fences of wire or walls of bricks rather than of locally obtained wood products. However, prevalence of use does not reveal the whole story. When the frequency of use or actual amounts used, irrespective of source, are examined, then use by township households was typically lower than the RDP and informal residential areas, reflecting their relatively higher income status.

Just giving the proportion of households collecting or buying tree products does not show the frequency at which they are collected or used. The households in this study regularly collected more frequently than they bought the tree products. As seen above, the urban residents did not just collect a small number of tree products, however they collected a wide range of tree products sourced in three ways particularly from own homesteads, other places and bought from traders. Fuelwood and fruits were the most regularly collected, hence were categorised as major tree products and the remainder fell within minor tree products. Murwendo (2011) and Davenport *et al.* (2011) also found that fuelwood was collected by the majority of urban households. Even though they did not report on the frequencies, it is likely that in these papers too, it was one of the most regularly collected tree products. Collecting and use of tree products is a means of mitigating poverty (Davenport *et al.*, 2011; Kalaba *et al.*, 2009) because they are collected for free. Depending on availability and need, collection of tree products can either increase in order to meet the household need or decrease if there is limited stock or when they do not need the tree products.

5.1 Fuelwood

Fuelwood was one of the major tree product used by urban residents. On average, a slightly higher proportion of all households were buying fuelwood (47.6%), followed by collection from other places and the least collected from trees on homesteads. MEA (2005) reported that between 25% and 50% of households in South Africa use fuelwood and the results in this study were within that range for the three towns. Households in the informal residential area emerged as major buyers and collectors of fuelwood from other places, whereas the township residents were collecting more on own homesteads. Corroborating work has reported that poor households depend on fuelwood for heating and cooking (Davenport *et al.*, 2011; Shackleton *et al.*, 2007). The number of households collecting or buying fuelwood varied from town to town and within each town. Tzaneen collected more from homesteads because there were many trees on homesteads and Zeerust, which had the least trees, recorded the lowest. Therefore, Zeerust residents collected more from the edges of town. No household in the RDP residential area in Tzaneen and very few households in the RDP residential area in Bela Bela collected fuelwood from homesteads because they had very small trees compared to the township and informal residential areas. Similar studies have reported that fuelwood can be sourced from trees within urban areas (Fuwape and Onyekwelu, 2011, Kuchelmeister, 2001; Uddin, 2006). Some households deliberately pruned trees on their homesteads while others cut down trees during house expansion and use the wood as fuelwood. Furthermore, a few households in the informal residential area in Bela Bela collected dead wood for energy purposes from street trees. Similarly, Fuwape and Onyekwelu (2011) and Uddin (2006) reported the same trends in West Africa and Bangladesh, respectively. Fuelwood was also collected from the edges of towns and other studies in South Africa (Davenport *et al.*, 2011), West Africa (Fuwape and Onyekwelu, 2011) and Zimbabwe (Murwendo, 2011) show that trees on the edges of towns are another important source of fuelwood to urban households. Close to half (42.2%) of households were collecting fuelwood from the edges of towns. This was within the range reported by Davenport *et al.* (2011) who reported that between 17% and 64% of urban households were collecting fuelwood from municipal commonages. However, a larger proportion of households in Zimbabwe were collecting fuelwood, over three-quarters of the households were collecting fuelwood from the edges of town (Murwendo, 2011). High proportions of households collecting fuelwood may be due to differences in poverty level in these two countries with South African households being richer.

In terms of the number of times households bought or collected fuelwood, it was clear that households were collecting more often per month from the edges of towns, followed by buying from traders and lastly collecting from homesteads at least once per year. The major source of fuelwood was the edges of towns, which is still part of the urban forest (Fuwape and Onyekwelu, 2011). The informal residential areas in Bela Bela and Zeerust had no electricity; hence fuelwood was a major source of

energy. Similarly, the RDP residential area in Tzaneen also did not have electricity and households collected fuelwood. Residential areas with no electricity collected fuelwood many times more per month than residential areas with electricity. Therefore, fuelwood will continue to be used by many households as it is one of the cheaper sources of energy and the tools required to use it are cheaper than electrical appliances (Openshaw, 2010; Shackleton *et al.*, 2007; Uddin, 2006). Given the lower reliability of electricity compared to fuelwood (Barnes and Floor, 1996; Openshaw, 2010), a situation worsened by frequent load-shedding and tariff increases, fuelwood will continue contributing to the livelihoods of the urban poor.

In regard to seasons, households collected and bought fuelwood more frequently during winter than summer. This is because of the lower temperatures and the consequent greater need for heat during this period, corroborating findings by MEA (2005) and Shackleton *et al.* (2006; 2007). This can be seen as a livelihood strategy in response to changes in weather. Households in the Eastern Cape increase the number of fires they make, which is accompanied by a higher number of collections per week in winter than in summer (Shackleton *et al.*, 2007). Hence, the use and collection of more fuelwood for energy in winter, increases in order to meet the additional energy deficits created by changes in weather conditions. This is aggravated by poor housing structures in the informal residential areas (UN-Habitat, 2003), which require more fuelwood to warm the space because they are poorly insulated.

5.2 Fruits

Households with fruit trees (48%) collected fruits more often on their own homesteads than they collected from other places (33%) and buying was the least frequently used source. Some households exchanged fruits thereby building social networks (Angelsen and Lund, 2011; Scoones, 1998). This is also another livelihood strategy that households use to access fruits that may not be available in supermarkets or on their own homesteads. However, most households (98%) were buying at least once per month, typically when they get paid or receive social grants. The percentage of all households collecting fruits on own homesteads was low because some of them did not have mature trees to collect from. Hence, collection of fruits on own homesteads is dependent on the abundance of trees the household has. Within towns most of the households were collecting fruits, except for the RDP residential areas in Tzaneen and Bela Bela and the informal residential area in Zeerust. Similarly, urban residents collected fruits from urban forests within towns in West Africa (Adekunle and Agbaje, 2012; Fuwape and Onyekwelu, 2011; Raoufou *et al.*, 2011) and on the edges of towns in South Africa and Zimbabwe (Davenport *et al.*, 2011; Murwendo, 2011). This made homesteads an important source of fruits. Exotic fruits were the most commonly collected fruits on own homesteads, including *M. indica*, *P. persica*, *C. sinensis*, *C. limon*, *P. americana*, *C. papaya*, *P. guajava*, *V. vinifera* and *M. nigra*. Correspondingly, Alam and Masum (2005), Fuwape and Onyekwelu (2011),

Ndaeyo (2007) and Winklerprins and de Souza (2005) reported similar fruits as being common on urban homesteads and mostly used fruits. Exotic fruits were the most bought fruits, with *M. domestica* and *C. sinensis* being the top two fruits. These fruits are the most commercialised and widely favoured fruits as revealed by the results.

A few households collected indigenous fruits which included *S. guineense*, *S. birrea* subsp. *caffra*, *D. mespiliformis*, *Searsia lancea*, *Ziziphus rivularis* and *Ficus sp.* Some indigenous fruits such *D. mespiliformis* and *S. birrea* were also reported to be among the fruits utilised by rural households in southern Africa (Shackleton and Shackleton, 2004; Shackleton *et al.*, 2010). These fruits were collected in small quantities, less frequently and mostly by children. Few households collected from other places including edges of towns. Murwendo (2011) also encountered lower percentages of urban households collecting *Azanza garkeana* and *Strychnos sp.* from the surrounding places. Some of the indigenous fruits mentioned above were collected from the edges of towns. However, no household mentioned any indigenous fruit among the fruits that they bought; this may mean that they are not highly favoured in these urban communities or there is no market for them. However, Hines and Eckman (1993) reported that indigenous fruits were not collected by villagers with access to exotic fruits such as *M. indica* and *C. papaya*. It can be seen therefore that indigenous fruits fail to compete with exotic fruits in urban markets.

Cash income generation from fruits was low. No household in this study collected indigenous fruits from the edges of towns for sale; however it does occur in some countries such as Zimbabwe (Murwendo, 2011). Considering exotic fruit species, only *M. indica* was being traded and only 12% of households in Tzaneen directly generated cash income by selling both unripe and ripe fruits to factories and people. This is a contrast to Shackleton (2006) and Kalaba *et al.* (2009) that fruits can be used to create direct cash income for households. Fruits however provide an indirect source of income to urban households (Chapter 4). Instead of spending money on buying fruits, urban residents save such hard earned income for other purposes by collecting free of charge (Murwendo, 2011). The indirect way in this case is more important than the direct way, since most fruits were just consumed within the households.

Fruits (particularly exotic) were an important source of food supplement to urban households, and hence they help to meet the nutrition requirements of urban residents, especially for vitamins (Murwendo, 2011), playing a crucial role in maintaining the health of people. Matching research work shows that fruits are used to meet nutritional needs on a day to day basis or in times of risks (Akinnifesi *et al.*, 2008; Frank *et al.*, 2011; Kalaba *et al.*, 2009). This demonstrated that fruits were an important source of food and contributes to food security of urban households, since urban poverty, malnutrition and food insecurity are increasing in urban households (Baker, 2008; Kuchelmeister, 1999; WRI, 1996). Even though indigenous fruits were not highly favoured by urban households, they

contain much higher percentages of vitamins than exotic fruits (Legwaila *et al.*, 2011). They can help meet the nutrition needs of urban households and perhaps this should be used to encourage households to plant more and conserve indigenous fruit trees.

Very few respondents added value to the fruits they collected. They were consumed in their raw form. This may be attributed to lack of knowledge or perhaps interest to process fruits or preference for fresh fruits. However, 46% of rural households in Zambia processed indigenous fruits into juices and porridges (Kalaba *et al.*, 2009). According to Shackleton *et al.* (2010), processing fruits reduces the vulnerability of households which depend on fruits in off the season, improves the shelf life and quality (Kalaba *et al.*, 2009).

Different fruits were available in different seasons and most purchased fruits were available throughout the year. Some fruits such as *M. indica* and *P. persica*, together with indigenous fruits, were available in summer (November to April). Likewise, Kalaba *et al.* (2009) found that indigenous fruits were only available from September to February. Whereas citrus fruits were available in winter and *M. domestica* was throughout the year in supermarkets, hence collecting and buying of fruits supplement each other. When some fruit species were not available in a particular season, other fruit species would be available when others were off-season and others would be bought from supermarkets.

To optimise the contribution of fruits to local livelihoods, there is need to make available the fruits that are most preferred by urban residents. Non invasive exotic fruit trees should be made available to urban residents as they have shown to be the main sources of food supplement rather than indigenous fruits. Seedlings for such trees should be made available to the people or train them to effectively propagate them on their own. However, one may argue that indigenous fruits should be given priority during planting of trees, but if this is imposed on households, then the whole process would fail. This is because tree selection for planting is typically influenced by benefits perceived by households (Uddin and Hassan, 2001).

5.3 Wood for building

There were a few households in Tzaneen which collected wood for building from trees on homesteads. Most trees on homesteads were not good for building material because they were not durable. However, those with desirable trees used the wood in building and repairing their houses in one informal residential area. Likewise, informal residential areas in West Africa collect wood for building houses from trees within urban areas (Fuwape and Onyekwelu, 2011; Kuchelmeister, 2000; 2001), in addition Shackleton (2006) and Uddin (2006) also wrote that urban residents collect wood for building from trees in urban areas; however this trend was only recorded in one town. More

households collected wood for building from the edges of towns than those which collected from homesteads. It must be pointed out that households in the informal residential area in Zeerust were the major collectors of wood for building. Similarly, Zimbabwean urban residents collect wood for building on the edges of town (Murwendo, 2011). Contrary to Fuwape and Onyekwelu (2011), who reported that people in informal residential areas collect wood for building from street trees, no household in this study collected wood for building from street trees. Many households, especially those in informal residential areas, also buy wood for building to add to the ones they collect.

5.4 Other tree products

The wood for fencing was mainly collected from the edges of towns, followed by buying and there were some households which collected from their homesteads. Like wood for building, this tree product was not collected every year as it lasts for many years. Households in the informal residential areas were the main collectors, because they were recently established, whereas some households in the township had brick walls resulting in few households collecting wood for fencing. However, Shackleton and Shackleton (2004) found a much high proportion ($62\pm 5.5\%$) of rural households collecting wood for fencing. In addition, forests were heavily used as sources of wood for fencing in rural Tanzania (Hines and Eckman, 1993).

Herbal medicines were also collected from trees on homesteads. Fruit trees were also used as sources of medicines. Likewise, trees in urban areas were sources of medicine in West Africa (Fuwape and Onyekwelu, 2011) and Bangladesh (Uddin, 2006); *S. birrea* was used as a pain killer, *M. indica* and *P. guajava* for diarrhoea and *C. limon* for flu. Trees on homesteads were used to treat minor ailments and other households combined the use of herbal medicines with modern medical care. This was also reported by Dahlberg (2005) in South Africa. Some trees on homesteads were sources of home basic health care, however most people seek specialised medical attention. These fruit trees served more than one purpose. Kalaba *et al.* (2009) found that fruit trees were also used for medicines. Some households were also collecting medicines from the edges of towns. Murwendo (2011) equally found the same thing and the percentage (33%) was also very small compared to households which collected other tree products. However, Davenport *et al.* (2011) reported that medicinal plants were the second most collected tree product by urban residents from urban commonages.

Homesteads were also a source of planting material; most households in the informal residential had a lot of self-seeded trees on their homesteads. Other households also collected compost, mulch from trees on homesteads, while others collected wood to make household tools such as cooking spoons, axe and hoe handles, however most of the household utensils were bought from traders. Similarly, Cocks and Bangay (2006) reported that only 10% of households collected wood for household utensils from the edge of town. A few households also collected seed pods for decorations and no

such tree product was bought. No household collected fodder for animals, contrary to reports by Fuwape and Onyekwelu (2011), which can be attributed to animals being left to fend for themselves or the respondents were not pastoralists.

Chapter Four

The direct-use value of tree products used by urban households

1 Introduction

Trees and tree products are cardinal in improving livelihoods of people in both urban and rural settings. Trees provide both consumptive and non-consumptive products, which are widely recognised and appreciated (Delang, 2006; Horst, 2006; Legwaila *et al.*, 2011). Among the consumptive tree products are fruits, fuelwood, wood for building, fencing, and household tools and herbal medicines (MEA, 2005). Others are seeds and seed pods for decoration, compost and mulch. Trees also sequester and store carbon, protect habitats, and reduce water runoff and soil erosion (Fuwape and Onyekwelu, 2011; Shackleton, 2006), which represent non-consumptive tree products. Even though trees and tree products contribute to livelihoods and the environment, the direct-use value of trees and tree products in urban areas are not well known. There are very few studies which have attempted to impute the value in urban areas (Davenport *et al.*, 2012; Shackleton *et al.*, 2010; Malimbwi *et al.*, 2010). Considering fruits, the few studies which have reported on the quantities of fruits used, have been on indigenous fruits. There is nothing on exotic fruits, despite them being the most common fruits consumed by both rural and urban households (Paumgarten *et al.*, 2005; Uddin and Hasan, 2001). In addition, the direct-use value of tree products is often unnoticed in studies dealing with the contribution of trees to local livelihoods (Andrew *et al.*, 2003; Delang, 2006). Determining the value of trees can justify the calls to conserve, and planting of, trees in urban areas. This chapter covers the direct-use value of tree products in urban areas.

1.1 The direct-use value of consumptive tree products

There are a number of methods which can be used to estimate the direct-use value of tree products. Tree products can either be classified as marketed or non-market products. The value of the former can be estimated by using the market price of the product, while the latter use indirect methods (Delang, 2006). The direct-use value of marketed tree products can be determined by own reported values as used in Zimbabwe (Cavendish, 2002) and South Africa (Davenport *et al.*, 2012; Shackleton and Shackleton, 2004). For non-marketed tree products, the most widely used methods to determine their value include the time taken to collect the product, contingent valuation (Adekunle and Agbaje, 2012; Boxall and Beckley, 2002), participatory environmental value, substitute products value and exchange value (Delang, 2006), and travel cost and hedonic pricing (Boxall and Beckley, 2002). All the above methods have both advantages and disadvantages in estimating both the value of non-marketed and marketed tree products (Boxall and Beckley, 2002; Cavendish, 2002; Delang, 2006). However, they offer a solution to understanding the amount of money that can be saved by households collecting tree products at no cash cost (Murwendo, 2011). Furthermore, it indicates the

additional income that would be spent on such tree products if the products were not available for free (Delang, 2006).

The direct-use value of tree products varies between sites and studies. It depends on the market price which is determined differently by local users. An approach commonly used, is where interviewees give the prices of the tree product(s) at which they or neighbours or households in the vicinity sell the produce (Cavendish, 2002). The quantity of tree products collected also differs significantly depending on tree cover, with regions having high forest cover recording high usage (Malimbwi *et al.*, 2010). In addition, the rate of collection differs depending on the importance of the tree product; some are used on a daily basis while others in time of crises (Shackleton, 2006; Shackleton and Shackleton, 2004). The most widely collected tree product in southern Africa is fuelwood (Davenport *et al.*, 2012; Murwendo, 2011; Shackleton *et al.*, 2007). Urban households in the Eastern Cape use a mean of 1.5 tonnes per household per annum (Shackleton *et al.*, 2007). However, rural households consume as much as 5.3 tonnes (Shackleton and Shackleton, 2004). In other parts of Africa, consumption of fuelwood is highly variable. In Botswana, each household consumes about 2.2 tonnes and 4.8 tonnes in urban and rural areas, respectively (ProBEC, 2006). Multiplying these amounts by local prices provides a direct-use value.

Moving from fuelwood to wood for building and fencing and fruits, an average of 185 large poles for house, kraal and fence construction and about 104 kg of wild fruits are collected by rural households per year in South Africa (Shackleton and Shackleton, 2004). Cunningham and Shackleton (2004) reported that between 19 and 165 kg fruits per household each year were collected. Considering herbal medicines, rural and urban households in South Africa consume 3.9 kg and 2.9 kg per household per annum (Shackleton *et al.*, 2010). Meanwhile higher quantities of herbal medicines are used in rural areas of Eritrea where 6.8 kg per household were consumed each year (Araia, 2005). It must be noted however that, households do not just depend on one type of medical care; they combine both traditional and modern medical care available to their advantage (Dahlberg, 2005). This is also applicable to other tree products as well; for example households combine the use of fuelwood with other energy forms (Shackleton *et al.*, 2007).

Even though large economic values have been reported on the contribution of urban forests at the city scale, there remains inadequate research on the value of urban trees and tree products at the household level (Shackleton, *et al.*, 2010; Stoffberg *et al.*, 2010) and, as yet no work has disaggregated the values across different types of residential areas, or in relation to household profiles. Consequently, this chapter sought to address the key question, “What is the direct-use value of tree products used by urban communities?”

2 Methods

2.1 Direct-use value

The user gross direct-use value was calculated as the product of the quantity (mass kg/household) used and closest available local price (price in Rand per kg) (Cavendish, 2002; Davenport *et al.* 2012; Shackleton and Shackleton, 2004). The amount of the consumptive tree products that were used or harvested were determined by weighing and then multiplying the mass by the local price given by the interviewee (Table 4.1). The value was expressed per household per annum. Due to the unavailability/seasonality of most products and that all households do not measure the products before use; weights of some products were not captured. Hence, households were asked to give equivalent weights in local units. Seasonality for fuelwood was taken into consideration. Winter was estimated to fall between April and August (five months) while summer accounted for the remaining seven months. Fruits were assumed to be available for six months and the figures calculated were expressed as per year. Similarly, Twine *et al.* (2003) estimated the fruiting season for wild fruits to be eight months. Herbal medicines were omitted because the weights were difficult to estimate and they were only used on an *ad hoc* basis. A head-load of fuelwood was estimated at 16.6±8.9 kg and a wheelbarrow at 44.0±18.6 kg. These figures were determined during data collection. However, other equivalent weights were obtained from Davenport *et al.* (2012), such as a van load as 382.5 kg and donkey cart load as 101 kg. An average between large and small poles for building and fencing were determined. The estimated price per unit is given in Table 4.1. Monetary values were calculated in South African Rand which at the time of data collection had an exchange rate of US\$1 = R8.20. All values are gross as labour and time or travel costs were not deducted.

Table 4.1: Mean (\pm sd) price of tree products per unit

Product	Units	Price per Unit (R)
Fruits	kg	2.10±1.26
Fuelwood	kg	1.05±0.51
Wood for building	Pole	42.83±23.65
Wood for fencing	Pole	35.92±23.36

The questionnaire used in Chapter 3 also recorded all sources of household income (cash and non-cash) to allow calculation of the relative contribution from urban trees.

3 Data analysis

Quantitative data were entered into Microsoft Excel, and later imported and analysed using Statistica 10. Descriptive statistics such as bar graphs, histograms, mean, standard deviation and percentages were determined. To compare means, a non-parametric test (Kruskal-Wallis test) was used since the

data were not normally distributed. This however did not include data with low sample size. In all analyses a significance level of 5% was applied.

4 Results

4.1 Quantities of fuelwood collected and bought per annum

Across all households, the largest quantity (846 tonnes p.a.) of fuelwood was collected mainly from other places such as edges of towns and beyond, followed by bought fuelwood (381 tonnes p.a.) and lastly fuelwood collected from own homesteads (49.1 tonnes p.a.), representing 66.3%, 29.9% and 3.8%, respectively. Tzaneen households collected the highest amount of fuelwood from their homesteads (39.7 tonnes p.a.), followed by Bela Bela and lastly Zeerust. Households in Tzaneen also bought the highest amount (182.8 tonnes p.a.) of fuelwood, but had the least amount of fuelwood collected from other places. Households in Zeerust recorded the greatest amount of fuelwood collected from other places, amounting to 441.8 tonnes p.a.

Breaking down the sources of collected fuelwood, excluding the one households bought, the largest proportion of fuelwood was sourced from urban trees within and around towns. Trees on homesteads provided 6.9% of the annual consumption and 67% came from the edges of towns. Whereas 12.7% was collected from far away areas and 13.4% came from wood processing companies. In all towns the trend was the same, urban forests were the main source of fuelwood (Table 4.2).

Table 4.2: Sources of fuelwood for three towns based on the quantity collected per annum

Town	Homesteads (%)	Edges of towns (%)	Beyond edges (%)	Other (%)
Tzaneen	17.6	43.8	0.1	38.5
Bela Bela	2.4	87.9	7.9	1.7
Zeerust	0.6	69.3	30.1	0
All	6.9	67.0	12.7	13.4

Considering residential areas, households in the township collected the highest amount of fuelwood from trees on own homesteads (24.1 tonnes p.a.) whereas the informal residential area collected the largest quantity from other places (509.4 tonnes) and bought the highest (157.9 tonnes) quantities of fuelwood per annum. The RDP residential areas collected the least amount of fuelwood from own homesteads while the households in the informal were intermediate. However, the households in RDP residential area recorded the second highest amount of fuelwood collected from other places and the least amount of bought fuelwood. The households in the township recorded the second highest amount of fuelwood bought from traders and collected the least amount of fuelwood from other places.

4.2 Direct-use value of fuelwood collected from homesteads

For all households in all three towns, an average of 0.2±0.5 tonnes of fuelwood per annum were collected from trees on homesteads, with a direct-use value of R189±506 per household per annum (Table 4.3). Households in Tzaneen collected significantly ($H = 12.5$; $p = 0.002$) the highest amount of fuelwood (0.4±1.3 tonnes p.a.) compared to households in Bela Bela and Zeerust and no significant differences existed between the last two towns. Following the same pattern, the direct-use value stood at R387±1 323 per household per annum. Among residential areas, the township collected significantly ($H = 15.6$; $p = 0.0004$) more (0.3±0.04 tonnes p.a.) than the informal residential area and the value was estimated at R268±492 per household per annum, while the RDP residential area was not considered due to low number of households collecting fuelwood from homesteads.

Table 4.3: The mean (\pm sd) annual quantity and annual direct-use value of fuelwood from three different sources (Comparing residential areas, unlike superscripts represent significant differences within columns. Note: Figures were rounded off and low samples have no superscripts)

Town	Res. area	Homestead		Other places		Bought	
		Qty (t)	Value (R)	Qty (t)	Value (R)	Qty (t)	Value (R)
Tzaneen	Informal	0.6±2.7 ^a	652±2840 ^a	4.5±11 ^c	4 732±11 529 ^c	2.5±2.4 ^a	2 588±2 568 ^a
	RDP	0±0	0±0	4.1±5.2 ^a	4 341±5 423 ^a	2.1±2.1 ^a	2 232±2 169 ^a
	Township	0.5±1.1 ^a	510±1 130 ^a	1.7±2.5 ^a	1 811±2 622 ^a	3.2±3.8 ^a	3 382±4 028 ^a
	All	0.4±1.3^a	387±1 323^a	3.5±6.2^b	3 628±6 525^b	2.6±2.8^a	2 734±2 922^a
Bela Bela	Informal	0.03±0.02 ^b	30±24 ^b	6.4±23.4 ^a	6 711±24 567 ^a	0.9±1.0 ^b	924±1 071 ^b
	RDP	0.04±0.02	45±22	1.5±1.4 ^a	1 569±1 440 ^a	1.8±6.3 ^b	1 904±6 629 ^b
	Township	0.2±0.3 ^a	227±307 ^a	1.1±1.4 ^a	1 137±1 450 ^a	1.1±2.4 ^b	1 162±2 485 ^b
	All	0.09±0.01^b	101±118^b	3.0±8.7^b	3 139±9 153^b	1.3±3.2^b	1 330±3 395^b
Zeerust	Informal	0.03±0.02 ^b	37±20 ^b	5.3±3.9 ^b	5 546±4 144 ^b	2.2±2.7 ^a	2 315±2 791 ^a
	RDP	0.1±0.2	132±174	3.0±4.2 ^a	3 194±4 360 ^a	1.5±3.5 ^b	1 616±3 724 ^b
	Township	0.06±0.04 ^b	68±29 ^b	6.9±18.8 ^a	7 201±19 706 ^a	1.2±2.3 ^b	1 231±2 397 ^b
	All	0.07±0.07^b	79±78^b	5.1±9.0^a	5 314±9 403^a	1.6±2.8^b	1 721±2 970^b
All	Informal	0.2±0.9 ^a	239±961 ^a	5.4±12.8 ^a	5 663±13 414 ^a	1.8±2.0 ^a	1 942±2 143 ^a
	RDP	0.06±0.2	59±65	2.9±3.6 ^b	3 035±3 741 ^b	1.8±4.0 ^a	1 918±4 174 ^a
	Township	0.3±0.04 ^b	268±492 ^b	3.2±7.6 ^b	3 383±7 926 ^b	1.8±2.8 ^a	1 925±2 970 ^a
	All	0.2±0.5	189±506	3.8±8.0	4 027±8 360	1.8±2.9	1 928±3 096

4.3 Direct-use value of fuelwood collected from other places

Across all three towns, households collected a mean of 3.8±8.0 tonnes of fuelwood per annum, with a direct-use value of R 4 027±8 360 per household per annum (Table 4.3). Households in Zeerust

collected significantly ($H = 20.0$; $p = 0.0002$) more (5.1 ± 9.0 tonnes p.a.) than Bela Bela and Tzaneen, with a direc

t-use value of R5 314 \pm 9 403 per household. However, there was no significant difference between Bela Bela and Tzaneen. Among residential areas, the informal residential area collected significantly ($H = 9.5$; $p = 0.009$) higher amounts of fuelwood (5.4 ± 12.8 tonnes p.a.) than the township and RDP residential areas, with a direct-use value of R5 663 \pm 13 414 per household per annum.

4.4 Fuelwood bought per household

Households in Tzaneen bought significantly ($H = 28.5$; $p = 0.00001$) more fuelwood (2.6 ± 2.8 tonnes p.a.) than Bela Bela and Zeerust; nevertheless no significant differences were recorded between Bela Bela and Zeerust (Table 4.3). Households in all three residential areas bought a similar quantity (1.8 tonnes p.a.) of fuelwood per annum and so was the value.

4.5 Direct-use value of fruits from own homesteads

The main source of fruits was from own homesteads, accounting for almost half (49.1%) of the fruits consumed by households. This was followed by those which they bought (38.7%) and lastly the ones they collected from other places (12.2%). Of all the fruits collected on own homesteads, the highest frequency was in Tzaneen (91.6%), followed by Zeerust (4.8%) and lastly Bela Bela (3.6%). Among the residential areas, the informal residential area recorded the largest prevalence (67.3%), followed by the township (28.9%) and lastly the RDP residential area (3.8%).

The households in Tzaneen collected significantly ($H = 21.9$; $p = 0.00001$) higher quantities of fruits per annum ($480 \pm 1 563$ kg) than those at Bela Bela, however there were no significant differences between Tzaneen and Zeerust and between Bela Bela and Zeerust (Table 4.4). The direct-use value among towns, ranged between R111 \pm 144 per household per annum in Bela Bela and R1 009 \pm 3 281 per household per annum in Tzaneen. Households in the informal residential areas in all towns collected significantly ($H = 19.8$; $p = 0.0001$) larger quantities of fruits ($447 \pm 1 270$ kg) than the households in the township, with a direct-use value of R175 \pm 229 to R938 \pm 2 667 per household per annum. Statistical tests were however not done to compare the RDP areas due to low sample size.

4.6 Direct-use value of fruits from other places

Residents of towns with few trees on homesteads collected fruits mostly from other places. Of all the fruits which were collected from other places, three-quarters (75.2%) were collected by households in Bela Bela, followed by households in Tzaneen (15.3%) and lastly Zeerust (9.5%). Among residential areas, the RDP area, which had the lowest number of homestead trees, collected the highest proportion of fruits from other places. Over half (54.6%) of the fruits collected from other places were

done by households in the RDP residential area. This was followed by households in the informal residential area (31.8%) and lastly households in the township (13.6%).

Table 4.4: The mean (\pm sd) annual quantity and annual direct-value of fruits on homesteads, other places and bought (Comparing residential areas, unlike superscripts represent significant differences within columns)

Town	Res. area	Homestead		Other places		Bought	
		Qty (kg)	Value (R)	Qty (kg)	Value (R)	Qty (kg)	Value
Tzaneen	Informal	1 054 \pm 3 663 ^a	2 214 \pm 7691 ^a	69 \pm 152 ^a	144 \pm 319 ^a	87 \pm 209 ^b	182 \pm 438 ^b
	RDP	16 \pm 22	34 \pm 46	47 \pm 171 ^a	98 \pm 358 ^a	681 \pm 2994 ^a	1 430 \pm 6286 ^a
	Township	371 \pm 1003 ^a	779 \pm 2107 ^a	65 \pm 209 ^b	137 \pm 438 ^b	106 \pm 488 ^a	2 23 \pm 1026 ^a
	All	480\pm1563^a	1 009\pm3281^a	60\pm177^a	126\pm372^a	291\pm1230^a	612\pm2584^a
Bela Bela	Informal	103 \pm 148 ^b	216 \pm 310 ^b	113 \pm 184 ^b	238 \pm 387 ^b	348 \pm 1267 ^a	731 \pm 2661 ^a
	RDP	0 \pm 0	0 \pm 0	220 \pm 27 ^b	463 \pm 577 ^b	77 \pm 154 ^b	163 \pm 323 ^b
	Township	55 \pm 58 ^b	116 \pm 121 ^b	88 \pm 76 ^a	185 \pm 159 ^a	65 \pm 86 ^b	137 \pm 180 ^b
	All	53\pm68^b	111\pm144^b	141\pm178^b	295\pm375^b	164\pm502^b	343\pm1055^b
Zeerust	Informal	183 \pm 0	384 \pm 0	93 \pm 93 ^a	195 \pm 195 ^a	58 \pm 160 ^b	123 \pm 335 ^b
	RDP	235 \pm 305	492 \pm 640	211 \pm 334 ^b	443 \pm 701 ^b	34 \pm 77 ^b	72 \pm 162 ^b
	Township	78 \pm 93 ^{ab}	163 \pm 196 ^{ab}	53 \pm 0 ^b	111 \pm 0 ^b	27 \pm 36 ^c	57 \pm 76 ^c
	All	165\pm133^{ab}	347\pm279^{ab}	119\pm142^b	250\pm299^b	40\pm91^c	84\pm191^c
All	Informal	447 \pm 1270 ^a	938 \pm 2667 ^a	92 \pm 143 ^a	192 \pm 301 ^a	164 \pm 545 ^a	345 \pm 1145 ^a
	RDP	84 \pm 109	175 \pm 229	159 \pm 260 ^a	335 \pm 545 ^a	264 \pm 1075 ^a	555 \pm 2257 ^a
	Township	168 \pm 385 ^b	353 \pm 808 ^b	69 \pm 95 ^a	144 \pm 199 ^a	66 \pm 204 ^a	139 \pm 427 ^a
	All	233\pm588	489\pm1235	107\pm166	224\pm348	165\pm608	346\pm1277

On average, the households in Tzaneen significantly ($H = 50.6$; $p = 0.00001$) collected lower quantities of fruits per annum from other places (60 \pm 177 kg) than Bela Bela and Zeerust (Table 4.4). In the same way the direct-use value per household per annum was R126 \pm 372 in Tzaneen compared to R295 \pm 375 per household per annum in Bela Bela. Across residential areas no significant differences were recorded on the quantities of fruits collected from other places per household per annum and the direct-use value ranged from R144 \pm 199 in the township to R335 \pm 545 per household per annum in the RDP residential areas.

4.7 Fruits bought per household

It can be recalled from Chapter 3 that almost every household bought fruits. Across towns, more than half (58.2%) of the total quantity of fruits consumed were bought by households in Tzaneen followed by Bela Bela (34.0%) and lastly Zeerust (7.8%). Considering residential areas, fruits were bought

most commonly by the households in the RDP residential area (51.5%) followed by the informal residential area (32.4%) and lastly the township households (16.1%).

Despite households in Tzaneen having the highest number of trees on homesteads, they bought significantly ($H = 34.4$; $p = 0.00001$) larger quantities of fruits per annum (291 ± 1230 kg) than Bela Bela which in turn bought more than Zeerust (Table 4.4). There were no significant differences among residential areas which bought fruits ranging between 66 ± 204 kg and 264 ± 1075 kg.

4.8 Direct-use value of wood for building

Most wood for building was bought. A total of 2 281 (76.1%) poles were bought per year across all the three towns. Households in Zeerust bought more (13 ± 9 poles) per household, followed by Tzaneen and lastly Bela Bela (Table 4.5). Households in the informal residential area bought the highest number of poles for building (13 ± 10 poles) per household per annum, followed by the township and lastly the RDP residential area (7 ± 4 poles) per household. The informal residential area in Zeerust bought significantly ($H = 6.7$; $p = 0.04$) more wood for building than the ones in Bela Bela (9 ± 6 poles).

Meanwhile 685 (22.8%) poles were collected from the edge of towns and beyond. Considering towns, households in Tzaneen collected the highest number of poles (16 ± 3 poles) to build and repair their houses followed by households in Zeerust and lastly Bela Bela. Similarly, the direct-use value of wood for building was $R671 \pm 141$ per household per annum in Tzaneen and least in Bela Bela (Table 4.5). Among residential areas, the township collected 16 ± 5 poles per households per annum followed by the informal and lastly the RDP residential areas. Due to low sample size statistical tests were not done. The direct-use value ranged from $R150 \pm 141$ in the RDP areas to $R555 \pm 420$ in the informal residential area and $R705 \pm 212$ in the township (Table 4.5).

Lastly, households in Tzaneen collected wood for building from trees on their own homesteads (Chapter 3). A total of 33 (1.1%) poles for building were collected on own homesteads in the informal and township residential areas per annum. The mean was 7 ± 1 poles per household with a direct-use value of $R278 \pm 57$ per household per annum (Table 4.5).

Table 4.5: The mean (\pm sd) annual quantity and annual direct-use value of wood for building (Comparing residential areas, unlike superscripts represent significant differences within columns, note: the table contains rounded off figures)

Town	Res. area	Homestead		Other places		Bought	
		Quantity	Value (R)	Quantity	Value (R)	Quantity	Value (R)
Tzaneen	Informal	5 \pm 4.0	193 \pm 173	13 \pm 10	557 \pm 424	14 \pm 13 ^{ab}	620 \pm 537 ^{ab}
	RDP	0 \pm 0	0 \pm 0	0 \pm 0	0 \pm 0	0 \pm 0	0 \pm 0
	Township	15 \pm 0	642 \pm 0	34 \pm 0	1 456 \pm 0	14 \pm 10	605 \pm 435
	All	7\pm1	278\pm57	16\pm3	671\pm141	10\pm8	408\pm324
Bela Bela	Informal	0 \pm 0	0 \pm 0	11 \pm 9	480 \pm 365	9 \pm 6 ^b	401 \pm 246 ^b
	RDP	0 \pm 0	0 \pm 0	0 \pm 0	0 \pm 0	11 \pm 6	460 \pm 274
	Township	0 \pm 0	0 \pm 0	0 \pm 0	0 \pm 0	7 \pm 3	315 \pm 127
	All	0\pm0	0\pm0	4\pm3	160\pm122	9\pm5	391\pm216
Zeerust	Informal	0 \pm 0	0 \pm 0	15 \pm 11	627 \pm 472	16 \pm 12 ^a	690 \pm 507 ^a
	RDP	0 \pm 0	0 \pm 0	11 \pm 10	450 \pm 423	10 \pm 6	420 \pm 269
	Township	0 \pm 0	0 \pm 0	15 \pm 15	660 \pm 636	14 \pm 9	594 \pm 374
	All	0\pm0	0\pm0	14\pm12	579\pm510	13\pm9	568\pm383
All	Informal	2 \pm 1	64 \pm 58	13 \pm 10	555 \pm 420	13 \pm 10	570 \pm 430
	RDP	0 \pm 0	0 \pm 0	4 \pm 3	150 \pm 141	7 \pm 4	292 \pm 181
	Township	5 \pm 0	214 \pm 0	16 \pm 5	705 \pm 212	12 \pm 7	505 \pm 312
	All	2\pm0	93\pm19	11\pm6	470\pm258	11\pm7	456\pm308

4.9 Quantity and direct-use value of wood for fencing

The highest quantity (64.2%) of wood for fencing was collected from other places mainly, the edges of towns, followed by those which were bought (19.9%) and lastly those collected from own homesteads (15.9%). Households in the informal residential area were the main collectors of wood for fencing. They collected 17 \pm 14 poles per household per year from edges of towns, 9 \pm 7 poles were bought per household and 12 \pm 11 poles per households were collected from own homesteads (Table 4.6). The direct-use value of wood for fencing was also higher in the informal residential area from R414 \pm 412 per household per annum for poles collected from homesteads and R533 \pm 504 per household per annum from other places.

Table 4.6: The mean (\pm sd) annual quantity per year and annual direct-use value of wood for fencing.

Note: Figures were rounded off.

Town	Res. area	Homestead		Other places		Bought	
		Quantity	Value (R)	Quantity	Value (R)	Quantity	Value (R)
Tzaneen	Informal	24 \pm 28	874 \pm 991	12 \pm 6	422 \pm 229	11 \pm 5	395 \pm 185
	RDP	0 \pm 0	0 \pm 0	0 \pm 0	0 \pm 0	0 \pm 0	0 \pm 0
	Township	0 \pm 0	0 \pm 0	0 \pm 0	0 \pm 0	0 \pm 0	0 \pm 0
	All	8\pm9	291\pm330	4\pm2	140\pm76	4\pm2	132\pm62
Bela Bela	Informal	4 \pm 2	135 \pm 68	12 \pm 13	444 \pm 483	10 \pm 8	352 \pm 292
	RDP	18 \pm 4	314 \pm 370	18 \pm 14	660 \pm 500	10 \pm 5	380 \pm 162
	Township	7 \pm 4	233 \pm 139	0 \pm 0	0 \pm 0	6 \pm 0	220 \pm 0
	All	9\pm3	227\pm192	10\pm9	368\pm327	9\pm4	314\pm151
Zeerust	Informal	7 \pm 5	233 \pm 178	26 \pm 22	733 \pm 799	8 \pm 7	275 \pm 270
	RDP	7 \pm 4	251 \pm 152	22 \pm 18	793 \pm 636	8 \pm 14	287 \pm 509
	Township	24 \pm 27	862 \pm 965	11 \pm 8	391 \pm 281	7 \pm 9	251 \pm 318
	All	13\pm12	449\pm431	20\pm16	639\pm572	8\pm10	271\pm365
All	Informal	12 \pm 11	414 \pm 412	17 \pm 14	533 \pm 504	9 \pm 7	341 \pm 248
	RDP	8 \pm 3	189 \pm 174	13 \pm 11	484 \pm 379	6 \pm 6	221 \pm 223
	Township	10 \pm 10	365 \pm 368	4 \pm 3	130 \pm 84	4 \pm 3	156 \pm 106
	All	10\pm9	323\pm318	11\pm9	382\pm325	7\pm5	239\pm193

4.10 Total household cash income

Households in this study had a number of sources of cash income, these included social grants, formal and informal employment and petty selling of fruits and fuelwood. The mean household annual cash income from these sources ranged from R16 500 to R53 400, with no significant differences between towns (Table 4.7). Among residential areas, the township had a significantly higher annual income ($H = 20.8$; $p = 0.00001$) (R34 900 \pm 22 700) than the RDP areas (R22 500) and the informal residential areas (R17 400), which were not significantly different to one another.

4.11 Contribution of trees and tree products to total household income

Cash income in all three towns and residential areas made the largest contribution to total household income (Table 4.8 and 4.9). Among the tree products, fuelwood had the largest contribution to the total household income. Zeerust being the poorest, had the largest (18.9%) contribution of fuelwood to total household income, followed by Bela Bela and lastly Tzaneen. The contribution of fuelwood to

total household income was largest (22.7%) in the informal residential area, followed by the RDP area and lastly the township.

Table 4.7: Mean (\pm sd) total annual cash income (Rand) from government social grants, salaries, petty trading and remittances for households in the three towns and residential areas (Comparing residential areas, unlike superscripts represent significant differences within columns)

Res. area	Town			
	Tzaneen	Bela Bela	Zeerust	All
Informal	18 900 \pm 21 900 ^a	16 900 \pm 16 000 ^a	16 500 \pm 10 500 ^a	17 400 \pm 16 200 ^a
RDP	21 100 \pm 26 600 ^a	25 100 \pm 18 000 ^a	21 200 \pm 23 600 ^a	22 500 \pm 22 700 ^a
Township	53 400 \pm 76 300 ^a	26 500 \pm 26 600 ^a	24 900 \pm 18 500 ^a	34 900 \pm 22 700 ^b
All	31 100\pm41 600^a	22 800\pm20 200^a	20 900\pm17 500^a	24 900\pm26 400

Contribution of fruits, wood for building and fencing did not show a consistent pattern. Consumptive tree products have a higher direct-use value to households with lower cash income. Households in Zeerust and the informal residential areas had the lowest annual cash income, thus the larger contribution from tree products.

Table 4.8: Total cash and tree product contribution to household income per year in three towns

Income sources	Town							
	Tzaneen		Bela Bela		Zeerust		All	
	Rand	(%)	Rand	(%)	Rand	(%)	Rand	(%)
Cash sources	31 100	82.7	22 800	83.9	20 900	73.2	24 933	80.1
Fuelwood	4 000	10.6	3 200	11.8	5 400	18.9	4 200	13.5
Fruits	1 140	3.0	410	1.5	600	2.1	717	2.3
Building	950	2.5	160	0.6	580	2.0	563	1.8
Fencing	432	1.1	596	2.2	1 090	3.8	706	2.3
Total	37 622	100	27 166	100	28 570	100	31 119	100

Table 4.9: Total cash and tree product contribution to household income per year in three residential areas

Income sources	Residential area							
	Informal		RDP		Township		All	
	Rand	(%)	Rand	(%)	Rand	(%)	Rand	(%)
Cash sources	17 400	66.9	22 500	83.5	34 900	86.1	24 933	80.0
Fuelwood	5 900	22.7	3 100	11.5	3 700	9.1	4233	13.6
Fruits	1 130	4.3	510	1.9	500	1.3	713	2.3
Building	620	2.4	150	0.6	920	2.3	563	1.8
Fencing	950	3.7	673	2.5	495	1.2	706	2.3
Total	26 000	100	26 933	100	40 515	100	31 149	100

5 Discussion

5.1 Direct-use value of tree products

Collected fuelwood was the most valuable tree product to urban livelihoods. The quantity of fuelwood collected was much higher than any other tree product considered. The largest proportion of fuelwood came from the edges of towns which is part of urban forests, while a lower quantity was collected from areas far from the edges of towns. Some of the fuelwood consumed also came from trees on own homesteads. Other studies (Malimbwi *et al.*, 2010; Openshaw, 2010) have reported a contrasting scenario that urban forests contribute only 10% or less to household fuelwood needs. However, this was not the case in this study. Two-thirds of the fuelwood collected were from edges of towns. Perhaps the other the studies (Malimbwi *et al.*, 2010; Openshaw, 2010) considered trees on edges of towns to be outside urban trees. In this study trees on the edges of towns were considered as part of urban forests (Bentsen *et al.*, 2010; Fuwape and Onyekwelu, 2011).

Collection of fuelwood from other places in Zeerust was large. The largest quantity of fuelwood collected from other places was in this town whereas Bela Bela collected the least. This can probably be attributed to lower cash income in Zeerust. Therefore, to meet other basic needs, they collected more fuelwood. In addition, change in weather conditions also affect the quantity collected. For example, the temperatures in winter can go as low as -0.4°C in Zeerust (Mucina *et al.*, 2005). Similarly, households in the informal residential areas collected more quantities of fuelwood than the other residential areas because their mean annual income was also significantly lower. This was also confirmed by PCA results which showed that households with low income were collecting more (Chapter 3). Corroborating work has shown that collection of fuelwood for energy is more by the households with lower cash income than those which receive higher cash income (Davenport *et al.*, 2011; Malimbwi *et al.*, 2010; Shackleton *et al.*, 2007). Households in Tzaneen, which were wealthier than the other two towns, bought more quantities of fuelwood than the ones which received lower cash incomes per annum. Although these results suggest a negative effect of wealth on use of fuelwood, the use of fuelwood cannot be ruled out completely as even households with electricity used fuelwood as an alternative source of energy, mirroring results in urban (Shackleton *et al.*, 2007) and rural (Madubansi and Shackleton, 2006) sites.

In all the three towns, a mean of 3.8 ± 8.0 tonnes per annum was collected from other places. In comparison, studies reported that 1.5 tonnes of fuelwood was used by urban households in Eastern Cape (Shackleton *et al.*, 2007). The difference between these studies can be attributed to the different vegetation types in which these studies were conducted. This shows that tree cover influences the quantity of fuelwood collected. This study was conducted in the savanna biome hence the relatively high availability of fuelwood. On a regional scale, countries with high forest cover also have high

quantities of fuelwood being collected (Malimbwi *et al.*, 2010). However, one may argue that the use of fuelwood is due to high poverty level in these countries with higher forest cover.

The direct-use value of fuelwood collected from other places (R4 027±8 360 per household p.a.) was higher than other studies. Davenport *et al.* (2012) reported a direct-use value for fuelwood ranging between R1 300 and R2 500 per urban household per annum. Correspondingly, the direct-use value for fuelwood in rural areas is high, falling between R1 000 and R12 000 per household per annum (Shackleton and Shackleton, 2004). Tree products in urban areas are highly valuable and their contribution to livelihoods may be similar as in rural areas. Since households in Zeerust collected the largest quantity of fuelwood, the direct-use value of fuelwood in this town was more than other towns. Among informal residential areas, the value of fuelwood in Bela Bela was higher than the other two informal residential areas. This shows the amount of money that can be spent on acquiring fuelwood. Collection therefore saves households especially in informal residential areas a lot of cash income which they would have spent on accessing the commodity.

The value of fuelwood on own homesteads was estimated at R189±500 per household per annum, which was low compared to the direct-use value of fuelwood from other places. The main contributing factor is that the direct-use value is determined by the quantity of the product used since the price was the same. Tzaneen, a town which had a lot of trees on homesteads, collected the largest amount of fuelwood from homesteads; hence the direct-use value of fuelwood in this town was higher than other towns. Similarly the value of fuelwood in Tzaneen's informal residential area was larger than the other two informal residential areas in the other two towns.

Households with trees on their own homesteads collected fruits from them. The largest proportion of fruits (49.1%) was collected on homesteads, which was supplemented by buying (38.7%) and collecting from other places (12.2%). Tzaneen produced the highest proportion of fruits (91.6%), reflecting the economy of the Greater Tzaneen Local Municipality which is driven by the horticultural and agricultural sectors (Greater Tzaneen Local Municipality IDP, 2011). The presence of orchards in the area has prompted households to plant fruit trees on homesteads. On average, households collected 233±588 kg of fruits per annum on homesteads. Other studies have reported that trees are mainly grown for fruits on homesteads (Chibende, 2009; Paumgarten *et al.*, 2005; Uddin and Hasan, 2001). Thus, the largest quantity of fruits in these towns was obtained from their own trees.

Households which had no fruit trees on their homesteads were either collecting fruits from other places or buying more quantities than others. A mean of 107±166 kg per annum of fruits were collected from other places. The quantity used by households collected from other places was within range with other studies in rural areas. Shackleton and Shackleton (2004) reported that rural households collected 104 kg of fruits each year. Cunningham and Shackleton (2004) also reported a

range of 20 kg to 200 kg per annum. However, these studies were conducted in rural areas and the fruits reported on were wild. In this study the fruits were mostly the domesticated ones of which the majority being exotic fruits with very few indigenous fruits.

The direct-use value of fruits collected on homesteads was estimated at R489±1 235 per household per annum and R224±348 per household per annum from other places. Twine *et al.* (2003) estimated the direct-use value of wild fruits in three villages in South Africa, ranging between R650 and R1 400 per household per annum. These figures were much higher than what was imputed for urban residents in this study. Using the time needed to collect the wild foods from natural forests in Thailand, Delang (2006) estimated the direct-use value of wild fruits to be equivalent to R252 per household per annum. The direct-use value was similar though they were from different contexts.

Some households in Tzaneen collected wood for building from tree trees on own homesteads. A total of 33 poles were collected which made up 1.1% of the wood collected. Other studies in West Africa (Fuwape and Onyekwelu, 2011) and Bangladesh (Uddin, 2006) have reported that poorer households use trees in urban areas for building their own houses. Nonetheless, none of these studies mentioned trees on homesteads as sources of fuelwood. The proportion of poles used for this purpose was the lowest compared to collection from other places being intermediate and buying providing the highest number of poles for building. The role of urban forests in supplying wood for building has been ignored, even though the proportions are low there were households making use of this urban forest resource. On average, seven poles for building were collected on homesteads whereas 11±6 poles were collected from other places and 11±7 were bought. In rural areas, Shackleton and Shackleton (2004) reported that an average of 185 poles was collected. Households in this study collected a much higher number. The value of wood for building on own homesteads was estimated at a lower value than wood for building collected from other places. It was estimated to be R278±57 per household per annum, this was only in Tzaneen. The direct-use value of wood for building that was collected from other places was estimated at R470±258 per household per annum. Lower values were again reported by Davenport *et al.* (2012) ranging between R36 and R64 per household per annum. The difference can be attributed to the number of trees that surround towns in these two provinces. Similarly, Twine *et al.* (2003) reported very low values ranging between R3 and R6 per household per annum. Wood for building in rural areas had a very low value, a situation which can be attributed to lack of market in rural areas.

Many poles for fencing were collected from the edges of towns than they were bought. In addition a few were collected from trees on own homesteads. They play a crucial in providing security in these residential areas especially the informal and RDP residential areas. Similar trends to wood for building were also exhibited on wood for fencing. The mean of 10±9 poles were collected on homesteads, 11±9 poles from other places and 7±5 poles were bought. The gross direct-use-value of

wood for fencing from trees on own homesteads was lower (R323±318) than the one for wood for fencing collected from other places (R382±325). Shackleton and Shackleton (2004), together with Davenport *et al.* (2012), combined the quantity and direct-use value for wood for building and fencing together. The figures found in this study were higher than the ones that were reported by these two papers. The direct-use value for wood for fencing was also lower in rural areas (Twine *et al.*, 2003). The reason can be the one alluded to above, this may mean low contribution to total household income.

5.2 Household income

Households do not just have one source of cash income. They however employ a number of cash income sources to ensure their survival (Campbell and Luckert, 2002; Davenport *et al.*, 2012). Households were deeply dependent on government social grants and it was observed that all households had at least one individual receiving one of the social grants (Appendix 2). They included child support (R270 per month), orphans (R750 per month), old age and sickness or disability grant (R1 140 per month). Similarly, Davenport *et al.* (2012) reported that urban households' main sources of cash income in the Eastern Cape were social grants. There is deep dependence on grants, suggesting that a lot of people in these communities are unemployed or earn very low cash income. Unemployment in South African townships and RDP residential areas is very high. With the continuous increase in the number of people in urban areas, many households and individuals will remain dependent on social grants. Hence, scraping of social grants would worsen the livelihoods of many urban residents since these households are poor (McConnachie and Shackleton, 2010).

Some households also had members who were involved in formal and informal employment, however the proportion of employed individuals was low (McConnachie and Shackleton, 2010). Albeit there were some people who were employed, there is a high likelihood that they were engaged by low paying jobs (Bela Bela Local Municipality IDP, 2010). In addition, cash income earned by other members of the household does not always contribute to total household cash income. Other households were also generating income through the petty sale of tree products, mainly fruits (Tzaneen) and much fewer households selling fuelwood. The other source of cash income was remittances, however very few households received remittances and no household received more than R1 000 per month hence its contribution to total cash income was minimal.

Mean cash income showed that households in the three towns were earning relatively similar cash incomes per annum. The township as a whole, however, was relatively wealthier than the RDP and informal residential areas. The mean cash income per annum ranged between R16 500 by households in the informal residential area and R53 400 in the township. Households in the townships in the three towns in Eastern Cape earned lower cash income ranging between R13 800 and R22 800 per annum

(Davenport *et al.*, 2012). A similar mean of R1 522 per month (R18 300 p.a.) was earned by households in the informal residential area in Pretoria (van Averbeke, 2007). Generally, households in previously black defined residential areas are poor, which is not the case for the affluent residential areas.

Cash income contributed the largest portion to total household income. Similarly, cash income mainly from employment and social grants accounted for the largest (83.1%) contribution to mean household income in informal residential areas in Pretoria (van Averbeke, 2007). The second contributor was fuelwood from both homesteads and other places. Fruits, wood for building and fencing also contributed much lower proportions. In rural areas of South Africa Twine *et al.* (2003) reported that wild fruits and fuelwood have the highest contribution of 25.9% and 14.8%, respectively, while wood for building and fencing contributes low proportions to total household income. However, this shows how important trees and tree products can be to local livelihoods. Tree products contributed approximately 20% to total household income among towns and residential areas. The contribution of tree products indicated how much money is saved. The money can therefore be used for other purposes. This shows how important trees on homesteads, edges of towns and beyond can contribute to household savings. Fuelwood can contribute up to R5 663 per annum, whereas fruits can contribute up to R1 000 per year to some households, wood for building up to R 1 500 and wood for fencing up to R800 per year. These figures were within the range reported by Shackleton and Shackleton (2004) of R1 000 to R12 000. However, the minimum in this study was much lower than the R1 000 per household per annum. These percentages are similar to some rural studies, however overlooked by urban developers and commentators.

Urban residents in Tzaneen, Bela Bela and Zeerust gather fuelwood on homesteads with an average value of between R79 and R387, and from other places with a cost of R3 100 to R5 700 per household per annum. This shows that fuelwood can provide an equivalent two months' cash income in the township and three months' income in the informal residential area. Similarly, the direct-use value for forest products was equivalent to four months' (144 days) wages in Thailand (Delang, 2006). Hence, collection of tree products can encourage households to plant more trees on their homesteads as well as conserving them in areas surrounding towns. If households were not collecting tree products, they would need additional money of the same proportion (0.6% to 22.7%) from cash income to meet energy, nutrition, housing and security needs. They may increase the quantity of tree products they buy, this entails more spending, a situation which may lead to vulnerability given the low annual cash income they receive.

Chapter Five

Synthesis, conclusions and recommendations

1 Introduction

The contribution of trees to rural households is well known and greatly appreciated in developing countries. In southern Africa, almost every household in rural areas collects and uses a wide range of trees and tree products (Kalaba *et al.*, 2009; Shackleton and Shackleton, 2004). With the increase in urban populations due to in-migration of people from rural to urban areas (Lehohla, 2006), trees within and around towns may contribute significantly to livelihoods of people in urban areas too. It has been reported that trees in urban areas potentially have the same benefits as those in rural areas (Fuwape and Onyekwelu, 2011; Kuchelmeister, 2000; 2001). However, the contribution of these trees is not well understood and is often overlooked by governments and research agencies. Thus, it was the aim of this study to determine the magnitude and nature of the direct contribution of trees and tree products to urban livelihoods and ascertain if and how the contribution differs between residential areas and households.

As many people leave rural areas for an initially uncertain life in towns and cities they may continue certain livelihood strategies and patterns of natural resource use with which they are familiar with from their previous rural livelihoods. Since many hold low skills levels and education, they may not easily find formal employment. Therefore, I hypothesised that they will continue to collect and use tree products for daily needs and perhaps as income generation as they wait to benefit from the opportunities afforded in urban areas in terms of services and secure employment.

There are sentiments among governments and research agencies that urban forestry is not important other than for biodiversity reasons and they should rather be focusing on other issues affecting urban communities. They consider urban forestry as an emerging issue and rated as a young science in developing countries (Bentsen *et al.*, 2010; Kuchelmeister, 1999). And the benefits from trees in urban areas are perceived to be insignificant and hence they are ignored. Yet there is very little work, especially quantitative analysis of the contribution, especially in developing countries (including South Africa), many of which have large populations of urban poor, This study sought to contribute in this regard by assessing the contribution of trees to local livelihoods in urban areas and determining the magnitude and nature of the direct contribution of trees and tree products to urban livelihoods in different residential areas. Three questions were posed:

- What is the abundance, distribution, richness and attributes of homestead trees in different urban residential areas?
- What are the tree products that urban households collect and use from trees on homesteads, other places and buy from traders?

- What is the direct-use value of tree products used by urban communities?

2 What is the abundance, distribution richness and attributes of homestead trees in different urban residential areas?

This study has revealed that a lot of urban residents participate in planting and managing trees on their homesteads. Regardless of the size and number of trees, the prevalence of trees was very high with at least 90% of households having trees on homesteads. Among towns, Zeerust had the highest proportions (94 %) of households with trees on the homesteads, followed by Tzaneen (90.4%) and lastly Bela Bela (87.3%). Households in the township had more (93.3%) trees, followed by the informal (92%) and RDP residential areas (86%). Particularly noteworthy was that the majority of households (71%) had actively planted trees on their homesteads, and a further 26% had protected or maintained trees that were already there when they took occupancy. Even the households in the recently established RDP residential areas had trees, although relatively small (most were less than 40 cm tall), indicating their intentions to promote some trees around their houses. This indicates a strong desire for and engagement with establishing trees by urban households at levels not much different to rural households. Similarly, rural households in Limpopo and Eastern Cape provinces also have interest in planting trees on their homesteads and all households had trees (Paumgarten *et al.*, 2005).

Household wealth did not have an effect on the prevalence of trees and the species planted. Both low and high income households planted trees. This is contrary to reports that richer households have more interest in planting trees (Barbosa *et al.*, 2007; Zhang *et al.*, 2008). The age, gender and education of the household head also did not influence the planting of trees (Chapter 2). This trend is contrary to findings in rural areas of the Eastern Cape (Shackleton *et al.*, 2008), where gender of the household head was correlated with significant differences in densities and number of species of trees around the homestead, being higher in male-headed households. New migrants who build houses on edges of towns have been accused of promoting deforestation and biodiversity loss (Cilliers *et al.*, 2004). This study found that whilst many households do collect tree products from the edges of towns, that they also plant or retain trees near their homesteads. In fact, the informal residential area had the highest proportion of households with trees around the homestead. Thus, there could be some losses of trees but households, especially in informal residential areas, retain and also introduce other tree species of their choice. Whether this represents a net gain or loss requires further investigation. However, the mean number of trees per household in this study was higher than rural households in the Eastern Cape, but five times lower than villages in Limpopo Province (Paumgarten *et al.*, 2005).

The town with the highest annual rainfall (Tzaneen) also had the largest proportion of households with trees. The pattern followed the gradient of rainfall with Zeerust recording the lowest proportion. The mean number of trees per household among towns also followed the same trend (Table 2.1).

Thus, the abundance of trees can be said to reflect the macro-environmental conditions of a particular location. This reflects the report by Uddin and Hasan (2001) that tree establishment is dependent on the environmental conditions of the area. For example, the soils in Bela Bela and Zeerust are so poor that they crack due to swelling and shrinking during summer and dry season (Mucina *et al.*, 2005), which may also contribute to the lower densities of trees compared to Tzaneen.

Tree density was highest in Tzaneen, followed by Zeerust which receives lower annual rainfall and lastly Bela Bela (Table 2.2). However, homestead plots in Zeerust were the smallest, hence giving rise to a higher tree density than Bela Bela which had a lot more trees than Zeerust (Table 2.1). The informal residential area had the highest density of trees, followed by the township and lastly the RDP residential area. This is mainly because of few trees in the relatively new RDP residential areas. The housing units in the informal residential area are very small (van Averbeke, 2007), this allows households in this area to plant more trees. The density of trees on urban homesteads ranged between 35.3 ± 7 trees per ha in Bela Bela and 59.3 ± 16.2 trees per ha in Tzaneen. This was within the range reported in rural homesteads of 24-198 trees per ha (Paumgarten *et al.*, 2005). Just as expected of the homesteads in the RDP residential area, they have fewer trees on their homesteads than the township. Even with respect to public green spaces (McConnachie *et al.*, 2008) and street trees (Kuruner-Chitepo and Shackleton, 2011), RDP residential areas have very low density, and requires intervention by planners and municipal authorities.

The amount of rain determined the size of trees across towns. Since Tzaneen receives the highest rainfall, had trees with the largest mean circumference and the smallest were recorded in Zeerust (Table 2.1). Therefore, environmental conditions such as moisture affect size of tree circumference. Given similar environmental conditions, trees in older residential areas grow faster and attain larger sizes and vice versa. However, the size of trees is defined by the age of the residential area. Townships which have been in existence for decades have trees of a larger circumference than the RDP residential area which was recently established and thus characterised by smaller trees. The RDP residential area can therefore be expected to have bigger trees with time. Most of the trees had a circumference less than 25 cm and the number of trees decreased as the circumference intervals increased. According to Paumgarten *et al.* (2005) the majority of trees on rural homesteads were of the same circumference interval. The largest tree was a *D. mespiliformis* individual with a basal circumference of 310 cm, found in the informal residential area in Tzaneen. Circumference size was negatively associated with the proportion of indigenous trees, which showed that on average, larger trees were alien tree species.

The number of species was not related to mean annual rainfall. A lot of tree species were recorded in Bela Bela while Tzaneen and Zeerust had the same number of species (Table 2.1). Urban residents in Bela Bela planted or maintained a greater diversity of tree species than the other towns. The mean

number of species was highest in the informal residential area and township but low in the RDP area. According to Uddin and Hasan (2001), selection of species depends on the preferences of local residents; the desire to collect various tree products makes households to plant a variety of trees. However, this was not linked to age, gender and education of the household head.

The highest proportion of indigenous tree species was encountered in Bela Bela which was more than half of the tree species counted in that town (Table 2.1). The other two towns had more alien tree species than indigenous tree species. Elsewhere in developing countries, the trend is the same. Trees on homesteads are dominated by alien trees (Alam and Masum, 2005; Ndaeyo, 2007; Winklerprins and de Souza, 2005). Similarly trees on rural homesteads are also dominated by alien species (Paumgarten *et al.*, 2005). Even in public urban green spaces, alien species predominate (McConnachie *et al.*, 2008; Kuruneri-Chitepo and Shackleton, 2011; Raoufou *et al.*, 2011). However, developed countries increasingly have more indigenous than alien tree species as biodiversity concerns and goals become more prominent (Clement and Moore, 2003; Frank *et al.*, 2006; Pysek, 1998). In each town, the informal residential area had a higher proportion of indigenous trees than the RDP area and township, suggesting that most trees there were maintained from the original natural vegetation when the plot was established, rather than planted. If there were to be any biodiversity conservation programmes, households in the informal residential area should be engaged towards not replacing these remnant indigenous species for alien ones. But this can only be achieved if there are plans to upgrade the informal residential areas. Depending on the location and ownership of invaded land, municipalities do upgrade them as finances permit (Landman and Napier, 2010).

Households with higher incomes had a low proportion of indigenous trees, possibly reflecting their ability to purchase and bring in any species they would like. The expectation were to find more alien trees in the informal residential area, since McConnachie *et al.* (2008) and McConnachie and Shackleton (2010) reported that public urban green spaces in poor residential areas have more alien trees. However, this was not the case with trees on homesteads as the informal residential area had more indigenous trees than the RDP and township residential areas. Generally, this study has shown there is a preference for exotic trees in urban areas. Mostly these are fruit trees and they form almost two-thirds of the top seven common tree species. The most common trees in Tzaneen were *M. indica* and *C. papaya*, whereas *Prunus persica* was the most common tree in Bela Bela and Zeerust. Similar studies have revealed the same trends where exotic fruit trees are the most common trees on homesteads (Alam and Masum, 2005; Ndaeyo, 2007; Winklerprins and de Souza, 2005). Invasive tree species in the top seven list included *T. stans*, *P. guajava*, *L. lucidum* and *J. mimosifolia*. These trees are classified as invasive trees in South Africa and pose a great danger to biodiversity and water resources, and thus should be removed (Nel *et al.*, 2004).

3 What are the tree products that urban households collect and use from trees on homesteads, other places and buy from traders?

Trees within urban areas, on the edges of towns and beyond provided various consumptive tree products to urban households. These tree products were divided into two groups. Tree products such as fuelwood and fruits were grouped together as major tree products because they were collected or bought and used at least once per month while those which were collected or bought less than once per month were categorised as minor tree products, which included wood for building, wood for fencing, herbal medicines, propagation material, compost, mulch, flowers, seed pods for decoration and household utensils.

Trees on homesteads provided fuelwood, however not frequently because there are too few trees for a regular supply. Collection of fuelwood on homesteads followed the moisture gradient (Figure 3.1), being most common in Tzaneen and least common in Zeerust. Whereas among the residential areas, the township had more households collecting fuelwood from trees on homesteads while the RDP area had the least. This is because the RDP homesteads had almost no trees of sufficient size for harvesting. The collection of fuelwood from trees on homesteads was the least used source of fuelwood, nonetheless it still contributed to the savings that households could make from using this free resource (Table 3.1). Correspondingly, poorer households in West Africa and Bangladesh collect fuelwood from trees within urban areas (Fuwape and Onyekwelu, 2011; Uddin, 2006). Trees on the edges of towns were the most important source of fuelwood for those urban households which use fuelwood for cooking and space heating. Supporting results from Masvingo (Zimbabwe) where three-quarters of urban residents collect fuelwood from the surrounding areas (Murwendo, 2011), in addition, mirroring results from around Gaborone in Botswana (Nkambwe and Sekhwela, 2006). The collection of fuelwood from other places negatively correlated with the moisture gradient between towns, with households in Zeerust using this source a great deal more than those in Bela Bela or Tzaneen. This potentially reflects the lower productivity of trees in drier environments and hence larger areas are required per household to supply household needs.

In all towns, households without electricity were the main collectors of fuelwood from other places. Two-thirds of households in the informal residential areas did not have electricity, hence the high proportion of households collecting fuelwood, with the households in the township having the lowest proportion of households collecting fuelwood from the other places. As long as fuelwood remains available, coupled with high in-migration of poor people, fuelwood will remain a major source of energy to households (Brouwer and Falcao, 2004). This is because fuelwood is cheap and readily available (Openshaw, 2010; Shackleton *et al.*, 2007; Uddin 2006). Fuelwood was also acquired by buying from supermarkets and vendors. This was the second most important source of fuelwood. There were more households in the informal residential areas which were buying fuelwood than the

township and RDP households. Most households in this had a limited alternative and affordable source of energy (Openshaw, 2010), therefore they had had a greater need for fuelwood. Despite households in informal residential area having the lowest cash incomes per annum, there were more households buying fuelwood to meet the needs for energy. This can make them more vulnerable to shocks as this reduces the household savings.

Collection, buying and use of fuelwood were dynamic and fluctuated with the change in seasons, being higher during winter than during summer (Table 3.1). This was done in order to cope with the decreasing temperature during winter. These trends are substantiated by findings from the Eastern Cape (Shackleton *et al.*, 2006; 2007). The materials of houses in the informal residential area, mostly from a mix of scrap metal, plastic and wooden poles, makes them poorly insulated (UN-Habitat, 2003), adding to the need for more fuelwood in cold seasons for heating. Fuelwood was mainly collected by households with lower cash incomes and there were no influences on the collection of fuelwood by the household characteristics such as age of the household head, or number of years the household has lived in the house or town. This corroborates the finding that poorer households are the ones who collect and use fuelwood (Fuwappe and Onyekwelu, 2011; Paumgarten and Shackleton, 2011; Shackleton *et al.*, 2007).

Trees on homesteads were key sources for edible fruits used by urban households. Almost two-thirds of households in Tzaneen collected fruits. This was followed by households in Zeerust and Bela Bela (Figure 3.4). More (72%) households in the township were collecting fruits from trees on homesteads than the informal households (49.3%) which were also more than the RDP households. This was due to young trees in the area, as alluded to above. Exotic fruits play a significant contribution to urban peoples' livelihoods, whereas indigenous fruits are more important in rural situations (Kalaba *et al.*, 2009; Shackleton *et al.*, 2010; Twine *et al.*, 2003). The fruits provide an instant source of nutrition when in season (Frank *et al.*, 2011; Fuwappe and Onyekwelu, 2011; Uddin, 2006). Though indigenous fruits are less popular among urban residents, they are more nutritious than exotic fruits ((Legwaila *et al.*, 2011). The frequency of collection ranged between once per month to 30 times per month in season. Urban households collected fruits from trees on homesteads more often than they collected from other places and bought from traders or supermarkets. This shows how important trees on homesteads contribute to local livelihoods in urban areas. The households in RDP areas had fewer old trees; hence more of these households were collecting from their friends' or relatives' homesteads in surrounding neighbourhoods. Fewer households in the informal and township residential area were collecting fruits from other places. In Zimbabwe, Murwendo (2011) noted that fewer households were collecting fruits from edges of town; this trend was also portrayed in this study. Almost every household was buying fruits and these were mainly *M. domestica*, *C. sinensis* and *Pyrus pyrifolia* (Table 3.4). No household mentioned any indigenous fruits among those fruits they buy. Trees on

homesteads are not the only source of fruits even though they were the most important source; they are supplemented by fruits collected from other places and buying from traders. In rural areas, indigenous fruits are traded to generate cash income (Kalaba *et al.*, 2009; Shackleton and Shackleton, 2004; Shackleton *et al.*, 2010), which is contrary to most urban situations, possibly because of lower densities and areas of land with fruit trees. Very few households were involved in the fruit trade; it was only one species (*M. indica*) which was traded in Tzaneen. Hence, fruits do not necessarily contribute to household cash income but rather play a role in saving cash from being spent.

In addition to fuelwood and fruits, there were a few households collecting wood for building from trees on homesteads (Table 3.5), however most households were collecting from the edges of towns. Households in the informal residential were the main collectors and buyers of wood for building, corroborating findings from urban areas in West Africa (Fuwape and Onyekwelu, 2011) and on the edges of towns in Zimbabwe (Murwendo, 2011). Collection of wood for building was negatively associated with income hence the households which earn lower income collect more, confirming that, poorer households are more reliant on tree products than wealthier households (Davenport *et al.*, 2011; Mulenga *et al.*, 2012). In this study, street trees were not used for building, contrasting the findings of Fuwape and Onyekwelu (2011) where households in West Africa collect fuelwood from street trees.

The wood for fencing was collected more often on the edges of towns, homesteads and less frequently bought from traders (Table 3.5). The proportions of households collecting poles for fencing were much lower than those in rural areas (Shackleton and Shackleton, 2004). More households in the informal residential area collected this product and more often. Some households were also using trees as live fences, among the tree species which were used for this purpose were *D. viscosa*, *T. stans* and *L. lucidum*. Using trees as live fences also act as a windbreak and trap dust, hence shielding the houses. This is important especially in the informal residential area where houses are made of poor quality material.

Urban trees also served as sources of herbal medicines, as recorded in other developing countries (Fuwape and Onyekwelu, 2011; Uddin, 2006). Homestead trees which served as herbal medicines were *C. limon*, *M. indica*, *P. guajava*, *S. birrea* and *S. guineense*. Households in the informal residential area were the main collectors of herbal medicines (Table 3.5). It must be noted however that these medicines are only used to treat simple illnesses. Urban households combine both herbal and modern medicines. Even rural households in South Africa do not just depend on herbal medicines (Dahlberg, 2005). It can also be noted that the medicinal trees listed above are also fruit trees, hence they serve multiple purposes. Likewise, Kalaba *et al.* (2009) reported that indigenous fruit trees are used for medicines as well. Herbal medicines were also collected from trees around the edges of towns. Murwendo (2011) found a small proportion of households collecting herbal medicines in

Masvingo city, but this was not the case with households in the Eastern Cape province (Davenport *et al.*, 2011). Households also collected other consumptive tree products, such as mulch and seeds for decoration, but the proportion doing so was very low.

4 What is the direct-use value of tree products used by urban communities?

Different quantities of tree products were consumed by urban households which had a strong effect on the calculated direct-use value. Quantity and direct-use value for four tree products were imputed in this study. These were fuelwood, fruits, wood for building and fencing. Other tree products were omitted because households were using relatively small amounts and/or on an *ad hoc* basis. Fuelwood was the most important consumptive tree product considered, being used by most households and in significant quantities. Most fuelwood (3.8 tonnes p.a.) was collected from other places, followed by purchased (1.8 tonnes p.a.) and lastly fuelwood collected from trees on homesteads (0.2 tonnes p.a.). Urban trees contributed the most fuelwood to urban households. According to Bentsen *et al.* (2010) and Fuwape and Onyekwelu (2011), trees on homesteads and edges of towns are part of urban forests. For this reason, trees within towns and surrounding areas were major sources of fuelwood. Rural households collect fuelwood from surrounding areas (Shackleton and Shackleton, 2004), likewise, urban households collect fuelwood from surrounding trees hence reducing the amount of time people walk to collect the tree products as well as the opportunity cost (Nkambwe and Sekhwela, 2006). However, Openshaw (2010) reported a contrasting scenario that the majority (90%) of fuelwood consumed in urban areas is collected from rural forests and that the difference (10%) accounts for fuelwood from urban trees.

The direct-use value of fuelwood collected from trees on homesteads was high, because it contributed to household income saving (R189 per household p.a.), while bought fuelwood represented household expenditure (R1 928 per household p.a.). Both the mean quantity and direct-use value of fuelwood collected from other places was higher in the poorer town (Zeerust) and residential areas (informal residential areas) than the mean for all households (Chapter 4). Consequently, the contribution of fuelwood was also higher in these areas. The contribution of fuelwood collected from other places in these areas was as high as R5 314 and R5 663 per household per annum, respectively. However, this was different for fuelwood collected on homesteads which was aligned along the moisture gradient. Collectively, collected fuelwood made a significant contribution to household savings, particularly to households in Zeerust and the informal residential areas. Without collecting fuelwood both from trees on homesteads and other places means that households would be buying more fuelwood. Given the low cash income generated, this can negatively affect the sustainability of urban livelihoods, consequently poverty would increase. The value of fuelwood by urban households in the Eastern Cape was estimated to range between R1 300 and R2 500 per household per annum (Davenport *et al.*, 2012). The gross direct-use value of natural resources in rural areas was estimated to range between

R900 and R12 000 (Shackleton and Shackleton, 2004). Tree products contributed up to 20% to total household income. A similar contribution to rural households has been reported in South Africa (Twine *et al.*, 2003). In urban areas alike, the majority (80%) come from cash income while natural resources account for the remainder in the Eastern Cape and Pretoria (Davenport *et al.*, 2012; van Averbek, 2007). The direct-use value of tree products was equivalent to two and three month's cash income in the township and informal residential areas, respectively, corroborating finding in Thailand that natural resources provide an equivalent of four month wages (Delang, 2006).

Larger quantities and direct-use value of fruits were recorded from trees on homesteads, with Tzaneen and the informal residential area recording the largest quantity (480 kg and 447 kg p.a.) representing a direct-use value of R1 009 and R938 per household per annum. Households in the RDP area collected the lowest quantity (84 kg p.a.) of fruits from trees on homesteads and hence the direct-use value was the low (R175 per household p.a.). However, they collected more (335 kg p.a.) from other places and the direct-use value was the largest among residential areas. Since they had few and young trees, households in this residential area also bought the largest quantity (264 kg p.a.) of fruits from traders and supermarkets. This showed that they were spending more time and money on fruits than households which had fruit trees on their homesteads. Similar quantities of fruits are also collected by rural households. According to Shackleton and Shackleton (2004) and Cunningham and Shackleton (2004) reported quantities of between 20 kg to 200 kg are consumed by each household per year. Other studies have shown that rural households in South Africa collect wild fruits from edges of villages worth between R650 and R1 400 per household per annum (Twine *et al.*, 2003). A lower direct-use value was reported in Thailand worth R252 per household per annum (Delang, 2006).

Wood for building and fencing were also collected both on homesteads and other places, the direct-use value was similar to fruits. A larger quantity (2 281 poles) of wood for building was bought from traders while wood for fencing (1 703 poles) was collected from other places. Households in the informal residential area were the main collectors (448 poles) and buyers (1 321 poles) of wood for building, so they were spending more. Davenport *et al.* (2012) estimated the direct-use value for wood for building to be between R26 and R54 per household per annum. Whereas Twine *et al.* (2003) reported very low values of R3 to R6 per household per annum. Households in the informal residential areas collected the largest numbers (393 poles) of wood for fencing from homesteads and other places (1 520 poles), in addition they also bought more (381 poles) than the other two residential areas. Hence, the direct-use value was much higher in the informal households.

Not unsurprisingly, this study revealed that the largest contribution to total household income was from cash sources, mainly wages and government welfare grants, with some from self-employment and trade. Yet remarkably, almost 20% of total household income was derived from tree products, mostly from fuelwood, fruits, wood for building and fencing. The contribution of tree products was

greater to households which earn lower cash income, for example to households in Zeerust and the informal residential areas. Fuelwood and fruits in rural areas contribute similar proportions (14.8% and 25.9%) to total household income (Twine *et al.*, 2003). In urban areas, van Averbeké (2007) reported that agriculture and tree products contribute about 17% to total household income in Pretoria, South Africa, whereas Ward (2012) reported that up to 12% more urban households would fall below the poverty line if the contributions of natural resources were excluded from incomes to urban households, and that this was higher for poorer households.

5 Conclusion

Urban trees undoubtedly contribute to the livelihoods of people in urban areas, offering ecological, social, psychological and economic benefits. This study considered only one dimension, namely the consumptive benefits of trees to urban households, and demonstrated that these can be considerable in both prevalence and in magnitude. Typically these benefits were higher for poorer households, but not restricted to them. Urban residents demonstrated their interest in planting and managing trees on their homesteads simply because of the benefits that are perceived to be derived from them. Some residents, without a water source on their homesteads walk long distances to fetch water for young trees. In some towns, trees are planted in poor soils and are vulnerable to disease and stray animals. Despite these and many more challenges, more than three quarters of the households had trees on their homesteads. These trees varied in size, number and species across all residential areas in all towns, but exotic fruit trees were the most common and were in high densities in the high rainfall town.

Major tree products were fuelwood and fruits, collected mainly from edges of towns and homesteads, respectively. The direct-use value of fuelwood made significant savings to total household income. The percentage of households collecting various tree products is similar to rural situations. There is need therefore for officials and planners to recognise the contribution of trees in urban areas to local livelihoods. Urban households collected these products from various sources such as homesteads, neighbourhoods, edges of towns and further afield, and buying from traders. Even though urban trees were an important source, it is not the sole source. It is however, supplemented by other sources.

Given the high number of households planting trees on their homesteads, homesteads can act as spots for conservation and livelihood benefits, especially in the informal residential areas. In addition, the high gross direct-use of tree products justifies the call for conservation of trees in urban areas. Apart from being sources of consumptive tree products, they also provide non-consumptive benefits. Trees on urban areas absorb carbon from the atmosphere, a process that helps in climate change mitigation. However, urban trees are affected by housing expansion and creation of new residential and commercial areas, which requires attention from researchers and authorities. These activities can lead

to reduction in the number of trees in urban areas and consequently hamper the survival of households.

6 Recommendations

Trees on the edges of towns are sources of fuelwood, wood for building and fencing, but are affected by developments and overexploitation, for example, they may be converted into residential or commercial areas. This reduces the tree resource on which many households depend. This can result in social, cultural and economic implication of households who use this resource. There is need therefore for urban planners to leave some natural areas where people who earn low cash income and do not have access to electricity can collect the tree products. Doing so would reduce the distance covered by women and children to collect fuelwood. In addition, this practice would also promote the conservation of indigenous tree species within urban areas. In order to promote conservation of trees around towns, municipalities should introduce permits for collecting tree products from these areas. An affordable fee should be set for a particular load of tree product a household can collect. Funds raised in this way can later be used for replanting trees and promotion of conservation of trees.

During the establishment of residential areas, trees should be retained on the plots rather than clearing the whole piece of land, particularly during the establishment of RDP residential areas. This calls for serious attention during the time of planning and designing of residential areas. In addition, there is a need to encourage the planting of various trees on homesteads to increase future consumptive and non-consumptive tree products. To mitigate deforestation caused by establishment of residential or commercial areas there is a need to plant more trees on homes and other urban spaces.

Since urbanisation and urban poverty in South Africa are increasing, and that studies in urban forestry are gaining momentum, there is need for future research in this field. Four areas in this regard are suggested. Firstly, there is need for monitoring if there would be an increase in the number of trees in the RDP residential areas as the current small trees mature. Secondly, a similar study should be extended to other towns and cities to provide a better understanding. In addition, there is need to assess whether ethnicity affect the planting, use and value of trees and tree product. This factor in this study was not looked at, but it is felt that it can shape the usage of urban forests. This is also open even to other countries in developing countries. This can also be extended further by contrasting urban forest uses in developed and developing countries. Thirdly, since the initial plan of doing this study in four residential areas failed, follow up studies should include the more affluent residential areas which were excluded from this study because residents were not willing to engage with the research team. There is also need to develop methods that can help collect data in this residential area such as the use of mails and enclosing self-addressed stamped envelopes. This however needs more planning. Finally, there is need to engage remote sensing studies to ascertain the proportion of urban

trees on homesteads relative to other spaces such as parks, streets and remnant lands. Aerial photographs should be used to assess changes in tree cover and abundance over time. This can help determine the effect of urbanisation on urban forests and composition over time.

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Appendices

Appendix 1: Interview schedule

The contribution of trees to local livelihoods in urban

My name is Humphrey Kaoma, a student at the Rhodes University in Grahamstown studying for a Masters of Science in Environmental Science. I am conducting research on the contribution of trees to local livelihoods which is one of the projects funded by South Africa-Netherlands Research Programme on Alternatives in Development (SANPAD). The objective of this work is to determine the magnitude and nature of the direct contribution of trees and tree products to local livelihoods in urban areas of differing socio-economic status. The research is trying to answer the following four questions. What tree products and species are used by urban households in areas of differing socio-economic status? What are the sources of the tree products used and how are the products procured by local household? What is the direct-use value of trees and tree products used by urban communities? And what is the extent of trees in private and public urban areas of differing socio-economic status?

This household was randomly selected from a municipality map/aerial photographs. Your participation is highly valued and all information given will be protected and treated with confidentiality. No harm will be inflicted on this household for answering questions in this interview. None of the results which identify you or your household head will be shared with anyone else including the authorities. You are still free to withdraw from the project at any time, even after giving consent and after the project commences. Once the project is completed, relevant policies may be written to enhance the livelihood of urban households,

This questionnaire contains five sections, section A is looking at the trees and tree products on your land, section B is looking at the trees and tree products that are collected from other places other than homesteads, section C is looking at the trees and tree products that are bought and section D is looking at the household profile. I will also need to take measurements and specimen of trees on your homestead. The estimated time for this interview is one hour.

Would you like to answer the questions in this questionnaire? Yes [] No []

If you have any further questions about this project please contact the project supervisor:

Prof. Charlie Shackleton.

Tel: +27-(0)46-603-7001

Signature

Interview no: _____ Date: _____ Town: _____ Suburb: _____

House no: _____ Translator: _____

SECTION A: TREES AND TREE PRODUCTS HARVESTED FROM THE HOMESTEAD PLOT

A1: Do you have any trees or bushes at your home? Yes No

A2: If yes, how were they established? (Tick *one or more* of the following)

They were there when we arrived We have planted them They have just grown up (self seeded)

A3: If you planted them, from where did you buy or collect them? _____

A4: Has the number of trees and bushes on your household plot changed over the past five years? Yes No

A5: If yes, how? Increased Decreased

A6: Why has it changed? _____

A7: Does anyone in your household regularly or irregularly use or sell any products collected from the trees and bushes from your home? Only use at home Only sell Both use and sell Neither

A8: If yes, please provide details of which products.

Tree products	Use at home	Sell	Tree products	Use at home	Sell
A: Wood for fuelwood			I: Seeds or seedlings from trees for propagation		
B: Wood for building			J: Leaves from trees for mulch		
C: Wood for fencing/kraals			K: Leaves from trees for compost		
D: Wood for furniture			L: Leaves from trees for animal fodder		
E: Wood for household utensils and tools			M: Fruits from trees		
F: Bark, leaves or roots from trees for medicines					
G: Flowers from trees for decoration					
H: Seeds or seed pods from trees for decoration or rattles					

Cont.

Tree products	Months when such products are available	How often do you collect in those months	How much each time (local units)	Who collects the products	What do you do with the tree products:			If sell:			
					Use	Sell	Both	Units	Units per month	Price per unit	Where do you sell from
Bark, leaves or roots from trees for herbal medicines											
Flowers from trees for decoration											
Seeds or seed pods from trees for decoration											
Seeds or seedlings from trees for propagation											
Leaves from trees for mulch											
Leaves from trees for compost											
Leaves from trees for animal fodder											

B:WOODY TREE PRODUCTS (Own home)

A10: Please provide details of the woody tree products that you or any household member harvest/collect from trees and bushes from your own homestead.

Tree products		How often do you harvest wood for such tree products	How much each time (Local units)	Who collects the wood	What do you do with the tree products:			If sell:			
					Use	Sell	Both	Units	Units per month	Price per unit	Where do you sell
Fuelwood	Summer										
	Winter										
Wood for building											
Wood for fencing											
Wood for furniture											
Household items											

SECTION B: COLLECTED TREES AND TREE PRODUCT

B1: Do you or any household member collect or sell any tree products from places within or at the edge of the town?

Only use at home Only sell Both use and sell Neither

B2: If yes, please provide details of which products.

Wood product	Use at home	Sell	Wood product	Use at home	Sell
A: Wood for fuelwood			H: Seeds or seedlings for propagation		
B: Wood for building			I: Leaves for mulch		
C: Wood for fencing			J: Leaves for compost		
D: Wood for furniture			K: Leaves for animal fodder		
E: Bark, leaves or roots for medicines			L: Fruits		
F: Flowers for decoration			M: Wood for household utensils and tools		
G: Seeds/seed pods for decoration/rattles					

A: FUELWOOD (*Other places*)

B3: Do you harvest fuelwood throughout the year? Yes No

B4: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep
Oct Nov Dec

B5: In summer, how often do you harvest fuelwood? _____per week month year

B6: Approximately how much do you harvest each time (local units)? _____

B7: In winter, how often do you harvest fuelwood? _____per week month year

B8: Approximately how much do you harvest each time (local units)? _____

B9: Who collects fuelwood? Men Women Children

B10: Where do you source them and how long does it take to reach the harvesting point?

B11: What mode of transport do you use?

B12: Has the number of trees changed over the past five years? Yes No

B13: If yes, how? Increased Decreased

B14: What tree species do you harvest for fuelwood?

B15: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

B: WOOD FOR BUILDING (*Other places*)

B16: Do you harvest wood for building throughout the year? Yes No

B17: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B18: How often do you harvest wood for building? _____ per week month year

B19: Approximately how much do you harvest each time (local units)? _____

B20: Who collects wood for building? Men Women Children

B21: Where do you source them and how long does it take to reach the harvesting point?

B22: What mode of transport do you use?

B23: Has the number of trees changed over the past five years? Yes No

B24: If yes, how? Increased Decreased

B25: What tree species do you harvest as wood for building?

B26: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what do price you sell each unit?	Where do you sell it?

C: WOOD FOR FENCING (*Other places*)

B27: Do you harvest wood for fencing/kraals throughout the year? Yes No

B28: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B29: How often do you harvest wood for fencing? _____ per week month year

B30: Approximately how much do you harvest each time (local units)? _____

B31: Who collects wood for fencing? Men Women Children

B32: Where do you source them and how long does it take to reach the harvesting point?

B33: What mode of transport do you use?

B34: Has the number of trees changed over the past five years? Yes No

B35: If yes, how? Increased Decreased

B36: What tree species do you harvest as wood for fencing?

B37: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

D: WOOD FOR FURNITURE (*Other places*)

B38: Do you harvest wood for furniture throughout the year? Yes No

B39: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B40: How often do you harvest wood for furniture? _____ per week month year

B41: Approximately how much do you harvest each time (local units)? _____

B42: Who collects wood for furniture? Men Women Children

B43: Where do you source them and how long does it take to reach the harvesting point?

B44: What mode of transport do you use?

B45: Has the number of trees changed over the past five years? Yes No

B46: If yes, how? Increased Decreased

B47: What tree species do you harvest as wood for furniture?

B48: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

E: BARK, LEAVES OR ROOTS FOR MEDICINE (Other places)

B49: Do you harvest bark, leaves or roots from trees for medicines throughout the year? Yes No

B50: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B51: How often do you harvest herbal medicines from trees? _____ per week month year

B52: Approximately how much do you harvest each time (local units)? _____

B53: Who collects herbal medicines from trees? Men Women Children

B54: Where do you source them and how long does it take to reach the harvesting point?

B55: What mode of transport do you use?

B56: Has the number of trees changed over the past five years? Yes No

B57: If yes, how? Increased Decreased

B58: What tree species do you harvest for herbal medicines?

B59: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

F: FLOWERS FOR DECORATION (Other places)

B60: Do you harvest flowers from trees for decoration throughout the year? Yes No

B61: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B62: How often do you harvest flowers from trees? _____ per week month year

B63: Approximately how much do you harvest each time (local units)? _____

B64: Who collects flowers from trees? Men Women Children

B65: Where do you source them and how long does it take to reach the harvesting point?

B66: What mode of transport do you use?

B67: Has the number of trees changed over the past five years? Yes No

B68: If yes, how? Increased Decreased

B69: What tree species do you harvest for flowers?

B70: If you sell some, please provide details:

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

G: SEEDS OR SEED PODS FOR DECORATION OR RATTLES (*Other places*)

B71: Do you harvest seeds or seed pods from trees for decoration or rattles throughout the year? Yes No

B72: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B73: How often do you harvest seeds or seed pods from trees? _____ per week month year

B74: Approximately how much do you harvest each time (local units)? _____

B75: Who collects seeds or seed pods from trees? Men Women Children

B76: Where do you source them and how long does it take to reach the harvesting point?

B77: What mode of transport do you use?

B78: Has the number of trees changed over the past five years? Yes No

B79: If yes, how? Increased Decreased

B80: What tree species do you harvest seeds or seed pods?

B81: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

H: SEEDS OR SEEDLINGS FOR PROPAGATION (*Other places*)

B82: Do you harvest seeds or seedlings from trees for propagation throughout the year? Yes No

B83: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B84: How often do you harvest seeds or seedlings from trees? _____ per week month year

B85: Approximately how much do you harvest each time (local units)? _____

B86: Who collects seeds or seedlings from tree for propagation? Men Women Children

B87: Where do you source them and how long does it take to reach the harvesting point?

B88: What mode of transport do you use?

B89: Has the number of trees changed over the past five years? Yes No

B90: If yes, how? Increased Decreased

B91: What tree species do you harvest seeds or seedlings for propagation?

B92: If you sell some, please provide details:

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

I: LEAVES FOR MULCH (*Other places*)

B93: Do you harvest leaves from trees for mulch throughout the year? Yes No

B94: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B95: How often do you harvest leaves from trees for mulch? _____per [] week [] month [] year

B96: Approximately how much do you harvest each time (local units)? _____

B97: Who collects leaves from trees for mulch? [] Men [] Women [] Children

B98: Where do you source them and how long does it take to reach the harvesting point?

B99: What mode of transport do you use?

B100: Has the number of trees changed over the past five years? [] Yes [] No

B101: If yes, how? [] Increased [] Decreased

B102: What tree species do you harvest leaves for mulch?

B103: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what do price you sell each unit?	Where do you sell it?

J: LEAVES FOR COMPOST (*Other places*)

B104: Do you harvest leaves from trees for compost throughout the year? [] Yes [] No

B105: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B106: How often do you harvest leaves from trees for compost? _____per [] week [] month [] year

B107: Approximately how much do you harvest each time (local units)? _____

B108: Who collects leaves from trees for compost? [] Men [] Women [] Children

B109: Where do you source them and how long does it take to reach the harvesting point?

B110: What mode of transport do you use?

B111: Has the number of trees changed over the past five years? [] Yes [] No

B112: If yes, how? [] Increased [] Decreased

B113: What tree species do you harvest leaves for compost?

B114: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

K: LEAVES FOR FODDER (*Other places*)

B115: Do you harvest leaves from trees for fodder throughout the year? Yes No

B116: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

B117: How often do you harvest leaves from trees for fodder? _____ per week month year

B118: Approximately how much do you harvest each time (local units)? _____

B119: Who collects leaves from trees for fodder? Men Women Children

B120: Where do you source them and how long does it take to reach the harvesting point?

B121: What mode of transport do you use?

B122: Has the number of trees changed over the past five years? Yes No

B123: If yes, how? Increased Decreased

B124: What tree species do you harvest for fodder?

B125: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

L: FRUITS (*Other places*)

B126: Please provide details of the fruits that you harvest from trees and bushes from other places:

Fruit/Species	Months when fruits are available	How often do you collect in those months	How much each time you harvest (local units)	Who collects the fruit	What do you do with the fruits:			If sell:			
					Eat	Sell	Both	Units	Units per month	Price per unit	Where do you sell

M: WOOD FOR HOUSEHOLD UTENSILS OR TOOLS (*Other places*)

B127: Please provide details of the household utensils that you make.

Household utensils/tools	How often do you harvest wood for such utensils/tools	How much each time wood do you use (Local units)	Who collects the wood	What do you do with the household items:			If sell:			
				Use	Sell	Both	Units	Units per month	Price per unit	Where do you sell
Stirring spoons										
Cooking spoons										
Bowls										
Mortars										
Axe handles										
Hoe handles										
Forks										
Plates										
Walking sticks										
Pick handles										
Curios										

SECTION C: PURCHASED TREE PRODUCTS

C1: Do you or any household member regularly or irregularly buy and/or resell any tree products from vendors?

buy to use at home only buy for resell only both neither

C2: If yes, please provide details of which products.

Wood products	Use at home	Resell	Wood product	Use at home	Resell
A: Wood for fuelwood			H: Seeds or seedlings for propagation		
B: Wood for building			I: Leaves for mulch		
C: Wood for fencing			J: Leaves for compost		
D: Wood for furniture			K: Leaves for animal fodder		
E: Bark, leaves or roots for medicines			L: Fruits		
F: Flowers for decoration			M: Wood for household utensils and tools		
G: Seeds/seed pods for decoration/rattles					

A: FUELWOOD (Purchased tree products)

C3: Do you buy fuelwood throughout the year? Yes No

C4: If no, during what months do you buy fuelwood? Jan Feb Mar Apr May Jun Jul Aug Sep
Oct Nov Dec

C5: In summer, how often do you buy fuelwood? _____ per week month year

C6: Approximately how much do you buy each time (local units)? _____

C7: In winter, how often do you buy fuelwood? _____ per week month year

C8: Approximately how much do you buy each time (local units)? _____

C9: Who buys fuelwood? Men Women Children

C10: What mode of transport do you use?

C11: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

B: WOOD FOR BUILDING (Purchased tree products)

C12: Do you buy wood for building throughout the year? Yes No

C13: If no, during what months do you buy? Jan Feb Mar Apr May Jun Jul Aug Sep
 Oct Nov Dec

C14: How often do you buy wood for building? _____ per [] week [] month [] year

C15: Approximately how much do you buy each time (local units)? _____

C16: Who buys wood for building? [] Men [] Women [] Children

C17: What mode of transport do you use?

C18: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

C: WOOD FOR FENCING (*Purchased tree products*)

C19: Do you buy wood for fencing/kraals throughout the year? [] Yes [] No

C20: If no, during what months do you buy? Jan Feb Mar Apr May Jun Jul Aug Sep
 Oct Nov Dec

C21: How often do you buy wood for fencing? _____ per [] week [] month [] year

C22: Approximately how much do you buy each time (local units)? _____

C23: Who buys wood for fencing? [] Men [] Women [] Children

C24: What mode of transport do you use?

C25: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

D: WOOD FOR FURNITURE (*Purchased tree products*)

C26: Do you buy wood for furniture throughout the year? [] Yes [] No

C27: If no, during what months do you buy? Jan Feb Mar Apr May Jun Jul Aug Sep
 Oct Nov Dec

C28: How often do you buy wood for furniture? _____ per [] week [] month [] year

C29: Approximately how much do you buy each time (local units)? _____

C30: Who buys wood for furniture? Men Women Children

C31: What mode of transport do you use?

C32: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

E: BARK, LEAVES OR ROOTS FOR MEDICINE (*Purchased tree products*)

C33: Do you buy bark, leaves or roots from trees for medicines throughout the year? Yes No

C34: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep
Oct Nov Dec

C35: How often do you buy herbal medicines from trees? _____per week month year

C36: Approximately how much do you buy each time (local units)? _____

C37: Who buys the herbal medicines from trees? Men Women Children

C38: What mode of transport do you use?

C39: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

F: FLOWERS FOR DECORATION (*Purchased tree products*)

C40: Do you buy flowers from trees for decoration throughout the year? Yes No

C41: If no, during what months do you buy? Jan Feb Mar Apr May Jun Jul Aug Sep
Oct Nov Dec

C42: How often do you buy flowers from trees? _____per week month year

C43: Approximately how much do you buy each time (local units)? _____

C44: Who buys the flowers from trees? Men Women Children

C45: what mode of transport do you use?

C46: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

G: SEEDS OR SEED PODS FOR DECORATION OR RATTLES (*Purchased tree products*)

C47: Do you buy seeds or seed pods from trees for decoration or rattles throughout the year? Yes
 No

C48: If no, during what months do you harvest? Jan Feb Mar Apr May Jun Jul Aug Sep
Oct Nov Dec

C49: How often do you buy seeds or seed pods from trees for decoration? _____per week
month year

C50: Approximately how much do you buy each time (local units)? _____

C51: Who buys the seeds or seed pods from trees? Men Women Children

C52: What mode of transport do you use?

C53: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

H: SEEDS OR SEEDLINGS FOR PROPAGATION (*Purchased tree products*)

C54: Do you buy seeds or seedlings from trees for propagation throughout the year? Yes
No

C55: If no, during what months do you buy? Jan Feb Mar Apr May Jun Jul Aug Sep
Oct Nov Dec

C56: How often do you buy seeds or seedlings from trees? _____per week month year

C57: Approximately how much do you buy each time (local units)? _____

C58: Who buys seeds or seedlings for propagation from trees? Men Women
Children

C59: What mode of transport do you use?

C60: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

I: LEAVES FOR MULCH (*Purchased tree products*)

C61: Do you buy leaves from trees for mulch throughout the year? Yes No

C62: If no, during what months do you buy? Jan Feb Mar Apr May Jun Jul Aug Sep
Oct Nov Dec

C63: How often do you buy leaves from trees for mulch? _____per week month year

C64: Approximately how much do you buy each time (local units)? _____

C65: Who buys leaves from trees for mulch? Men Women Children

C66: What mode of transport do you use?

C67: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

J: LEAVES FOR COMPOST (*Purchased tree products*)

C68: Do you buy leaves from trees for compost throughout the year? Yes No

C69: If no, during what months do you buy? Jan Feb Mar Apr May Jun Jul Aug Sep
Oct Nov Dec

C70: How often do you buy leaves from trees for compost? _____per week month year

C71: Approximately how much do you buy each time (local units)? _____

C72: Who buys leaves from trees for compost? Men Women Children

C73: What mode of transport do you use?

C74: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

K: LEAVES FOR FODDER (*Purchased tree products*)

C75: Do you buy leaves from trees for fodder throughout the year? Yes No

C76: If no, during what months do you buy? Jan Feb Mar Apr May Jun Jul Aug Sep
Oct Nov Dec

C77: How often do you buy leaves from trees for fodder? _____per [] week [] month [] year

C78: Approximately how much do you buy each time (local units)? _____

C79: Who buys leaves from trees for fodder? [] Men [] Women [] Children

C80: What mode of transport do you use?

C81: If you sell some, please provide details.

In what units do you sell it?	How many units do you sell per month?	At what price do you sell each unit?	Where do you sell it?

M: WOOD FOR HOUSEHOLD UTENSILS OR TOOLS (*Purchased tree products*)

C83: Please provide details of the household utensils that you buy.

Household items	How often do you buy	How much do you buy each time (Local units/no)	Who buy the utensils	What do you do with the household items:			If sell:			
				Use	Resell	Both	Units	Units per month/no	Price per unit	Where do you sell from
Stirring spoons										
Cooking spoons										
Bowls										
Mortars										
Axe handles										
Hoe handles										
Forks										
Plates										
Walking sticks										
Pick handles										
Curios										

SECTION D: HOUSEHOLD PROFILE

D1: Please provide details.

First name	Sex	Age	Education (years)	Occupation.	Occupation detail	Govt grants	Remittances		Income /month
							What	Freq	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Key: **U** = Unemployed; **FE** = Formal employment; **CE** = Casual employment; **SF** = Self employed; **S** = Student; **O** = Old age; **D** = Disability; **C** = Child grant.

D2: How much do you spend on electricity bills per month? _____

D3: How many bedrooms are in the house? _____

D4: How many times do you eat meat in a month? _____

D5: How many years has your household lived in this house? _____

D6: How many years has your household lived in this town? _____.

D7: Where did you move from? _____

Appendix 2: Household profile

Town	Residential area	Characteristics										
		Gender	Age (yrs)	Education (yrs)	Persons working	Persons on grants	Persons/bed room	Electricity (R)	Meat (per month)	House (yrs)	Town (yrs)	% Migrants (<10 yrs)
		Male (%)										
Tzaneen	Informal	56	43.4±13.9	7.0±5.3	0.7±0.8	1.4±1.2	2.1±0.9	124±100	16.2±12.3	7.3±5.2	33.8±18.9	18
	RDP	70	38.1±10.0	9.5±4.0	0.8±0.7	0.7±1.0	1.8±0	0	17.2±11.2	1.3±0.8	32.1±15.9	14
	Township	58	55.2±17.0	8.6±5.6	1.2±10.0	1.2±1.3	1.7±1.6	264±161	28.1±40.6	29.8±16.4	44.4±17.8	6
	All	61.3	45.6±13.6	8.4±5	0.9±3.8	1.1±1.2	1.9±0.8	129±87	20.5±21.4	12.8±7.5	36.8±17.5	12.7
Bela Bela	Informal	66	40.2±11.1	7.3±3.5	1.0±1.0	1.6±1.4	2.6±3.7	0	15.4±13.6	4.0±3.0	16.5±14.1	54
	RDP	76	41.4±10.0	8.4±4.1	1.2±0.9	1.9±1.6	2.4±9	170±116	23.9±10.7	2.1±1.1	25.9±16.8	38
	Township	48	55.3±18.9	7.4±4.8	0.7±0.8	1.8±1.9	1.7±1.7	281±185	24.8±9.3	37.0±21.8	45.9±22.6	16
	All	63.3	45.6±13.3	7.7±4.1	1±0.9	1.8±1.6	2.2±4.8	150±100	21.4±11.2	14.4±8.6	29.4±17.8	36
Zeerust	Informal	46	48.5±14.0	2.9±3.9	0.5±0.6	2.2±1.3	2.9±2.4	0	3.1±4.9	4.0±2.5	31.7±24.6	40
	RDP	48	46.2±13.6	6.6±4.7	0.6±0.7	1.8±1.6	2.5±1.9	168±100	8.1±9.2	10.4±4.5	42.8±14.6	0
	Township	36	52.3±16.3	6.0±4.8	1.0±1.0	2.2±1.9	1.9±2.7	190±145	9.1±8.6	29.7±21.8	48.3±19.8	10
	All	43.3	49±14.6	5.2±4.5	0.7±0.8	2.1±1.6	2.4±2.3	119±82	6.8±7.6	14.7±9.6	41±19.7	16.7
Combined	Informal	56	44±13	5.7±4.2	0.7±0.8	1.7±1.3	2.5±2.3	41±33	11.6±10.3	5.1±3.6	27.3±19.2	37.3
	RDP	64.7	41.9±11.2	8.2±4.3	0.9±0.8	1.5±1.4	2.2±3.6	113±72	16.4±10.4	4.6±2.1	33.6±15.8	17.3
	Township	47.3	54.3±17.4	7.3±5.1	1±4	1.7±1.7	1.8±2	245±164	20.7±19.5	32.2±20	46.2±20.1	10.7
	All	56	46.7±13.9	7.1±4.5	0.9±1.9	1.7±1.5	2.2±2.6	133±90	16.2±13.4	14±8.6	35.7±18.3	21.8