Urban Forestry & Urban Greening 13 (2014) 244–252

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug

Collection of urban tree products by households in poorer residential areas of three South African towns

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ARTICLE INFO

Keywords:
Firewood
Fruits
Non-timber forest products
Poverty
Urban gardens
Urban green spaces

ABSTRACT

The high rates of urban in-migration and poverty common in many developing country towns potentially increases the reliance of urban populations on the direct benefits provided by trees. Yet understanding of the extent of such use and the sources of these tree products is limited. Here we report on the extent of use of urban tree products by 450 households in the poorer areas of three towns along a rainfall gradient based on household questionnaires. We considered the proportion of households making use of each of several tree products and the collection or purchasing frequency which we disaggregated by source of the product, including trees in homesteads, urban spaces, edges of towns and via purchase from traders. Most households (91%) used firewood, which was most frequently collected from the urban fringe or purchased, although one-third at times also collected firewood from trees on their home plot. All households used fruits, most commonly sourced through purchase (98%), but nearly half of whom also supplemented by harvesting fruits from their home plot. Other products used included wood for building, fencing and utensils, herbal medicines, planting material and mulch. Collection of products from urban homestead trees was highest amongst households in the informal settlements and least in the more established townships. Residents of new low-cost housing areas made extensive use of urban tree products harvested in urban spaces because they had fewer homestead trees than residents of informal areas or townships. Overall, urban residents made use of a wide array of tangible products from trees which they sourced from a variety of places, including their homestead plot. This urges that planning agencies ensure that homestead plot sizes or other urban spaces that provide tree products are large enough to support the direct needs of poorer urban residents.

Introduction

The goods and services provided by trees for human wellbeing are well known and are increasingly being quantified (Dobbs et al., 2011; Soares et al., 2011). For example, trees provide timber for energy, construction, utensils and carving; fruits, seeds and leaves for food; fronds, bark and roots for fibre; resins, bark and roots for medicines and flowers and seed pods for decoration. Environmentally, trees help reduce stormwater runoff and hence soil erosion, they provide windbreaks for agricultural crops and residential areas, they sequester carbon and ameliorate the urban heat island effect and poor air quality, and they also provide habitat and food for other organisms. Non-consumptive benefits provided by trees include shade, inspiration, psychological rejuvenation, a sense of place, and for some they contribute to cultural identity. Taken together, these multiple benefits have the potential to improve human wellbeing, enhance local environmental sustainability and reduce poverty (MEA, 2005; Shackleton, 2006).

Although trees provide both consumptive and non-consumptive benefits, these different benefits have not received equal attention within research and policy arenas. International literature and understandings of urban forestry are largely founded on work in developed countries, particularly North America and Europe (Shackleton, 2012; Wendel et al., 2012). Most urban households in these regions make little use of consumptive products from trees in their local environment and hence research has focussed on non-consumptive and ecological benefits, with some exceptions such as McLain et al. (2012) and Poe et al. (2013). In contrast, it can be observed that poorer urban communities in developing countries make use of tree products from their local environment (Long and Nair, 1999). For example, Davenport et al. (2011) showed that up to 70% of poorer urban households in three small towns in South Africa regularly collected at least one tree product (mostly firewood, herbal medicines and fodder for livestock) for direct use.

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http://dx.doi.org/10.1016/j.ufug.2014.02.002
1618-8667/

However, there is limited research regarding the extent of such use by urban communities in the developing world, who is most involved, the contribution the products make to household well-being, how it differs within and between towns and how it impacts the urban forests. Such knowledge is necessary to understand the livelihoods and factors that contribute to the wellbeing of the urban poor, who are likely to make most use of consumptive tree products from their immediate environment.

Consumptive tree products can bring direct income into the household through trade (Kalaba et al., 2009; Murwendo, 2011) and indirectly by cash saving through the supply of free products (Murwendo, 2011). They may also be useful as a temporary safety-net in the event of a household suffering a setback, such a retrenchment, illness or death (Shackleton and Shackleton, 2004; Zulu and Richardson, 2013). It may also be that the most recent migrants to urban areas make use of tree products as a carryover of their former rural livelihood practices or culture (Stoian, 2005; Shackleton, 2012). Thus, there is a need for attention to the consumptive uses of tree products in urban settings of the developing world, the contextual factors that hinder or enhance such use, the significance of such use in local livelihoods and consequently the types of urban forestry policies and programmes needed in such contexts.

The extensive markets for tree products in urban areas attest to the consumer demand that they enjoy. For instance, in many cities of the developing world, firewood or charcoal are the main household energy source (Arnold et al., 2006; Malimbwi et al., 2010). Brouwer and Falcão (2004) reported that 74% of urban households in the capital city of Mozambique (Maputo) used charcoal, and whilst use was more prevalent amongst poorer households, it was not restricted to the poor. In small towns of the Eastern Cape Shackleton et al. (2007) found that 65% of households used firewood as a primary energy source. These fuels can be transported over large distances to provide urban consumers with energy (e.g. Shively et al., 2010), but some of this firewood is harvested within or on the peripheries of towns (Openshaw, 2010; Davenport et al., 2011). Similarly, wild fruits are widely sold in urban markets. For example, Termote et al. (2012) describe the trade in wild fruits and other edible species by dozens of traders in Kisangani (DRC). Traditional medicines from tree products are perhaps transported the furthest to meet urban consumer demand, with Williams et al. (2000) and Botha et al. (2004) revealing supply chains transporting over hundreds of kilometres, even crossing international boundaries, to the largest urban centres in southern Africa. These sectoral studies amply demonstrate that urban households make extensive use of tree products. However, there are few studies that have looked at all tree products simultaneously, using the household as the unit of analysis, rather than the product, and little work as examined the source of the tree products used by urban households.

The potential sources of tree goods for these markets and urban use are varied. For high value resources, or those with significant demand, they may be transported into urban areas over long distances from rural regions where there is greater resource supply. Additionally, some tree products may be harvested from within and at the fringes of urban areas (Fuwape and Onyekwelu, 2011). Given the lower volumes of tree products available from these places because of their small spatial extent, harvesting is likely to be largely for household use rather than for sale on local markets. Vacant patches and the edges of towns are particularly vibrant areas for harvesting of tree products because of the rapid rate of land transformation (Nkambwe and Sekhwela, 2006; Murwendo, 2011). These zones may also be the temporary home to new, poor migrants to the town who reside in informal structures until they can secure a better livelihood in the urban economy. Lastly, tree products can also be harvested by residents from their own homesteads. Although the magnitude of supply of tree products from individual homesteads it likely to be constrained by the small size of homestead plots, the aggregate volumes across entire suburbs or towns could potentially be large. However, the harvesting of tree products from these private spaces has been hardly examined internationally.

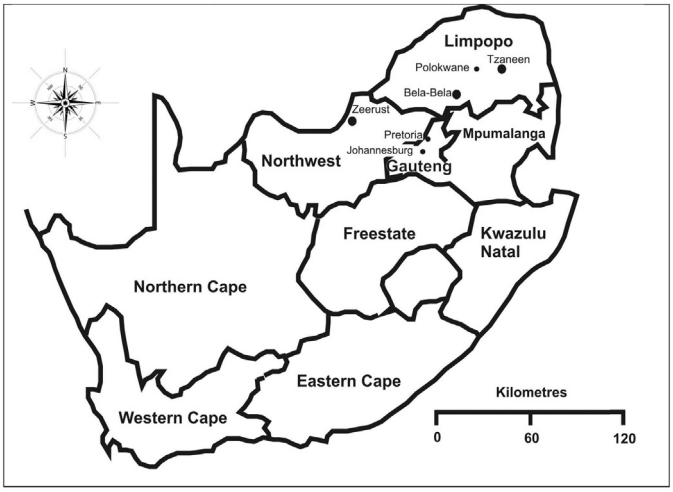

Fig. 1. The three study towns (Tzaneen, Bela Bela and Zeerust) in South Africa.

As elsewhere in the world, towns in South Africa can be readily separated into different zones. Residential zones are typically differentiated on the basis of socio-economics, with the relatively affluent suburbs enjoying large plot sizes with substantial gardens (Lubbe et al., 2010). The relatively poorer suburbs house higher densities of residents on smaller plots (McConnachie and Shackleton, 2010). In most towns of the region, these poorer residential areas can be further differentiated into two zones, and in South Africa, into three. In South Africa, up until the early 1990s, poorer African residents were restricted by apartheid government policies to living in racially segregated areas called townships. Since that time the national government initiated a massive low-cost housing scheme as part of the post-apartheid Reconstruction and Development Programme. Hence, these new low cost areas are called RDP areas or RDP houses. They are reserved for the indigent. The third area that can be discerned in most South African towns is one dominated by informal housing (Hunter and Posel, 2012). Typically these are occupied by new migrants to a town who are waiting to be allocated an RDP house. In the meantime, they settle on vacant land on the edges of towns or apparently unused lands within the town and construct houses from cheap or scavenged materials. In large and long-established informal areas some local municipalities may provide some services (such as piped water, refuse removal, street lights and electricity).

Within the context of the above, this study sought to establish the extent of use and sources of tree products consumed by households in the poorer suburbs of three small South African towns. We hypothesised that use would be least amongst the more established and wealthier (relatively) households of the townships than those in the more transient informal areas and amongst the poorer households of the RDP suburbs.

Study areas

The study was conducted in three small South African towns in the Limpopo and North West provinces (Fig. 1), which span a precipitation gradient of relatively high to low rainfall. Tzaneen receives approximately 850–900 mm p.a., Bela Bela, 650 mm p.a. and Zeerust 550 mm p.a. (Mucina and Rutherford, 2006). Census data on population sizes of specific towns are imprecise because the

national census enumeration boundaries do not correspond with town boundaries but extend beyond and include rural populations and villages some distance away. Best estimates for the three towns are that each has a population of approximately 25,000–35,000. Socio-demographic statistics therefore refer to the whole municipality, rather than the towns specifically. Illiteracy ranges from 25% in Bela Bela to about 40% in Tzaneen and Zeerust (Stats, 2008). Consequently, unemployment is high, ranging from approximately 25% in Tzaneen to over 50% in Zeerust, with large proportions of people relying on government social grants for cash income (Stats, 2008). Approximately 5% of households in Tzaneen live in informal housing, 10% in Zeerust and 20–25% in Bele Bela (Stats, 2008). At the time of field work there was no grid electricity supply to the informal areas of Bele Bela and Zeerust and the RDP area of Tzaneen.

Tzaneen (23° 50′ S; 30° 10′ E) is located 800 m.a.s.l. in the north-east of Limpopo Province (Fig. 1). The study was conducted in Nkowankowa, RDP and Lusaka (informal) residential areas. The dominant soils are shallow to deep, sandy, gravelly and well drained (Mucina and Rutherford, 2006). The region enjoys a sub-tropical climate, with hot wet summers (October–May) and mild dry winters. The mean monthly maximum temperature is 36.4 °C experienced in January and a minimum of 3.9 °C in June (Mucina and Rutherford, 2006). Frost is rare. The vegetation is broad-leaved savanna of the Tzaneen Sour Bushveld dominated by species such as *Faurea saligna* Harv., *Parinari curatellifolia* Planch. ex Benth., *Pterocarpus angolensis* DC. and *Sclerocarya birrea* (A. Rich.) Hochst. *subsp. caffra* (Sond.) Kokwaro (Mucina and Rutherford, 2006).

Bela Bela (24° 54′ S 28° 20′ E) is located at approximately 1000 m.a.s.l. in the south of the Limpopo Province (Fig. 1). Most soils are red-yellow apedal, freely drained with high base status and self-mulching, along with black, vertic clays (Mucina and Rutherford, 2006). Most rainfall is received as convectional thunderstorms during the summer. The average monthly maximum temperature is 35.2 °C, and the minimum temperature −2 °C in July (Mucina and Rutherford, 2006). Winter frost is common. The vegetation of this region is the Springbokvlakte Thornveld (Mucina and Rutherford, 2006), dominated by acacia species such as *Acacia karroo* Hayne, *A. mellifera* (Vahl) Benth., *A. nilotica* (L.) Willd. ex Del. and *A. tenuspina* I.Verd. (Mucina and Rutherford, 2006).

Zeerust (25° 32′ S 26° 6′ E) is found in North West province at an altitude of approximately 1100 m.a.s.l. (Fig. 1). The dominant soils are deep, red-yellow, apedal and well drained. Zeerust receives summer rainfall but experiences frequent droughts (Mucina and Rutherford, 2006). The mean maximum monthly temperature is 36.7 °C occurring in January and the coldest month is June with a minimum of just below freezing; frost is common. The vegetation is Zeerust Thornveld, dominated by *Acacia burkei* Benth., *A. erioloba* E.Mey., *A. mellifera* (Vahl) Benth. subsp. *detinens* (Burch.) Brenan, *A. nilotica* (L.) Willd. ex Del, *A. tortilis* (Forsk.) Hayne subsp. *heteracantha* (Burch.) Brenan and *Terminalia sericea* Burch. ex DC. (Mucina and Rutherford, 2006).

Methods

Aerial photographs (scale 1: 5000) were used to identify the RDP, township and informal areas in each town. Using a grid overlay, 50 households were randomly selected from each residential area per town. At each randomly selected house, we conducted an interview regarding the use of tree products and the sources of those products. 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 as they wished. Data collection included weekends and public holidays to accommodate people who work. Interviews were conducted in English or translated into a preferred local language. Each interview lasted approximately one hour. The interview schedule had four sections. The first dealt with tree products that were collected on the respondent's homestead whilst the second considered tree products that were collected from other places (neighbourhood, within town, edges of towns and beyond edges of towns). The third section considered tree products that were bought from traders. The fourth recorded details of the household profile.

We divided the tree products used into either major or minor. Major ones were collected or bought by most households at least once per month, and included firewood and fruits. Minor ones were procured less than once per month and comprised wood for building and fencing, bark or roots for herbal medicines, propagation material, mulch, compost, flowers and seed pods for decoration and wood for household utensils. Prior to data analysis the answers to the structured interview schedule were coded to facilitate numeric analysis. Data were entered into Microsoft Excel and were analysed using the Statistica 10. Initial data exploration via principle components analysis (PCA) was used to portray the relationships between household demographics and collection of major tree products; bought major products were not included because nearly all households bought firewood and fruits and thus there was no variation between households for discrimination within the PCA. For normally distributed data, a two-way ANOVA was used to analyse continuous data and compare town and suburbs simultaneously, however a non-parametric Kruskal–Wallis test was used for data which were not normally distributed. Differences in the proportions of household using specific products were tested via a chi-squared test.

Table 1
The proportion of households (%) collecting and buying tree products within three residential areas of three towns. (Within columns unlike superscripts denote a significant difference between suburbs of the same town and unlike numbers denote significant differences between towns as a whole).

Town	Residential area	Proportion (%) of households procuring at least one tree product	
		Collecting	Buying
Tzaneen	Informal	56[a]	96[a]
	RDP	62[a]	92[a]
	Township	22[b]	100[a]
	All	46.7[1]	96.0[1]
Bela Bela	Informal	88[a]	100[a]
	RDP	80[a]	100[a]
	Township	50[b]	100[a]
	All	76.0[2]	100.0[1]
Zeerust	Informal	98[a]	100[a]
	RDP	74[b]	100[a]
	Township	52 [c]	100[a]
	All	74.7[2]	100.0[1]
Combined	Informal	80.7[a]	98.7[a]
	RDP	72.0[a]	97.3[a]
	Township	41.3[b]	100.0[a]
	All	64.7	98.7

Results

Mean residency time in the respondents' current dwelling was markedly longer ($F = 238.0$; $p < 0.0001$) in the township (31.7 ± 20.4 years) than either the RDP suburbs (4.6 ± 4.9 years) or informal settlements (4.9 ± 3.9), which were not significantly different from one another. All households made use of at least one tree product (Table 1). Nearly all households purchased tree products, most commonly fruit. Additionally, two-thirds of households also harvested one or more products from trees on their homesteads or elsewhere. This was most prevalent amongst residents of the informal and RDP areas, and significantly less amongst households in the townships ($\chi^2 = 33.6$; $p < 0.0001$). A significantly lower proportion

Table 2
The proportion (%) of households collecting firewood and fruits from their own plots, elsewhere or buying within three residential areas of three towns. (Within columns unlike superscripts denote a significant difference between suburbs of the same town and unlike numbers denote significant differences between towns as a whole).

Town	Residential area	Firewood			Fruits		
		Collecting at home	Collecting elsewhere	Buying	Collecting at home	Collecting elsewhere	Buying
Tzaneen	Informal	70^{a}	26^{b}	72^{a}	96^{a}	38^{a}	98^{a}
	RDP	0^{b}	42^{a}	44^{b}	4^{b}	40^{a}	94^{a}
	Township	76^{a}	6^{c}	32^{b}	95^{a}	22^{b}	100^{a}
	All	48^{1}	25^{2}	49^{1}	64^{1}	33^{2}	97^{1}
Bela Bela	Informal	36^{b}	70^{a}	44^{b}	36^{b}	70^{a}	100^{a}
	RDP	5^{c}	38^{b}	50^{b}	2^{c}	58^{a}	100^{a}
	Township	58^{a}	18^{c}	68^{a}	78^{a}	38^{a}	100^{a}
	All	33^{2}	32^{2}	53^{1}	39^{2}	55^{1}	100^{1}
Zeerust	Informal	26^{a}	96^{a}	46^{a}	14^{c}	4^{b}	100^{a}
	RDP	36^{a}	58^{b}	32^{b}	62^{a}	24^{a}	100^{a}
	Township	8^{b}	36^{c}	44^{ab}	46^{b}	6^{b}	98^{a}
	All	22^{2}	63^{1}	41^{1}	41^{2}	11^{3}	99^{1}
Combined	Informal	43^{a}	64^{a}	53^{a}	49^{b}	37^{a}	99^{a}
	RDP	13^{b}	45^{b}	42^{a}	23^{c}	41^{a}	98^{a}
	Township	48^{a}	20^{c}	48^{a}	73^{a}	22^{b}	99^{a}
	All	34	43	48	48	33	99

of residents of Tzaneen collected tree products than residents in Bela Bela ($\chi^2 = 18.8$; $p < 0.0001$) or Zeerust ($\chi^2 = 16.5$; $p < 0.0001$), which were not significantly different from one another.

Firewood

Firewood was a widely used resource across all residential areas and towns (91.3% of entire sample), with the greatest prevalence of use (96%) recorded in the informal settlement of Zeerust (Table 2). This area had no electricity. Despite the relatively small homestead plot sizes, up to 70% of households collected some firewood from their home plot. However, a greater percentage collected firewood elsewhere, or bought it (Table 2) than collected it from their homestead.

Firewood collected on homesteads

Averaged across all towns and suburbs about one-third of households harvested firewood from their home plot (Table 2). There was a strong gradient of most use from the wettest town of Tzaneen (48%), to the more arid site of Zeerust (22%), with Bela Bela (33%) in between. Within towns, collection of firewood from the homestead plot was greatest among township residents and least in the newer and smaller plots of the RDP suburbs ($1468 \pm 67\ m^2$ in RDP areas, $1756 \pm 80\ m^2$ in informal settlements and $1948 \pm 98\ m^2$ in townships ($F = 6.23$; $p < 0.005$)).

Even though collection of firewood from homestead plots was relatively common, the frequency of collection was low compared to firewood collected from other places or bought (Table 3). Because of the small size of homestead plots households generally collected firewood there only 1–3 times per year, except for monthly in the informal residential area in Tzaneen (Table 3). Households in Tzaneen collected firewood from homesteads significantly more ($H = 17.1$; $p = 0.02$) frequently than those in Bela Bela and Zeerust.

Firewood collected from other places

Remnant areas and the edges of towns were important sources of firewood for almost half of all households (Table 2). Not unsurprisingly, respondents in suburbs without household electricity supply (the informal areas of Bela Bela and Zeerust and the RDP suburb of Tzaneen) had double the proportion of households (63%) collecting firewood throughout the town than those households with electricity (31%) (Table 2), and they did so 2–3 times more frequently (Table 3). The prevalence of use of other places for firewood collection was opposite that for collection from homestead plots, i.e. more households in the driest town (Zeerust) collected from other places, with Bela Bela intermediate and in the wettest town (Tzaneen) it was the least. Across residential areas, almost two-thirds of residents of the informal areas collected firewood elsewhere, the RDP suburbs were intermediate and the townships had the least. The most common place for collecting was at the edge of town (17% of households in Tzaneen, 35% in Bela Bela and 51% in Zeerust) relative to only 1%, 5% and 9%, respectively, who collected firewood from beyond the edges of towns. All collecting households also collected off-cuts from industrial areas and remnant or unused areas within towns. There were strong seasonal differences in the frequency of collection reflecting increased needs in the colder

Table 3
Monthly frequency (±sd) of firewood collection and buying. (Comparing towns, unlike superscripts represent significant differences within columns. Note: Seasonality was not considered for firewood collected from trees on homesteads because the products were collected mainly once in a year).

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

* Statistical analysis was not applicable because of low sample size.

Table 4
Percentage of households collecting the top seven fruit species on own homesteads and mean (±sd) frequency per month (Comparing towns, unlike superscripts represent significant differences within columns).

Town	Informal	(%)	RDP	(%)	Township	(%)
Tzaneen	*Mangifera indica*	96	*Carica papaya*	2	*Mangifera indica*	94
	Psidium guajava	16	*Psidium guajava*	2	*Citrus sinensis*	30
	Carica papaya	14			*Carica papaya*	26
	Citrus limon	14			*Persea americana*	20
	Persea americana	14			*Citrus limon*	16
	Vitis vinifera	14			*Litchi chinensis*	12
	Syzygium guineense	12			*Vitis vinifera*	10
	Mean freq./month	24.6 ± 22.9^{a}		$2.7 \pm 2.4^{*}$		16.8 ± 14.1^{a}
Bela Bela	*Prunus persica*	24	*Prunus persica*	2	*Prunus persica*	46
	Morus nigra	14			*Citrus limon*	32
	Citrus limon	2			*Carica papaya*	22
	Passiflora edulis.	2			*Mangifera indica*	20
	Psidium guajava	2			*Psidium guajava*	20
	Sclerocarya birrea	2			*Morus nigra*	18
	Vitis vinifera	2			*Passiflora edulis*	16
	Mean freq./month	25.5 ± 29.9^{a}		$30.5 \pm 0^{*}$		20.2 ± 13.4^{a}
Zeerust	*Morus nigra*	10	*Prunus persica*	52	*Prunus persica*	32
	Prunus persica	4	*Passiflora edulis*	6	*Vitis vinifera*	14
	Searsia lancea	4	*Malus domestica*	4	*Ficus sp.* (Feiye)	10
	Ziziphus rivularis		*Morus nigra*	4	*Morus nigra*	10
			Vitis vinifera	4	*Citrus sinensis*	6
			Citrus limon	2	*Citrus limon*	4
			Citrus sinensis	2	*Prunus armeniaca*	4
	Mean freq./month	21.4 ± 13.7^{a}		23.6 ± 13.1		17.3 ± 13.1^{a}

* Statistical test was not applicable because of low sample size.

winter months. Winter use was lowest in Tzaneen, which is the town with the mildest winters ($H = 25.2$; $p = 0.0001$).

Firewood purchased from traders and stores

The third source of firewood was through purchase from vendors, with almost half (48%) the sampled households doing so (Table 2). There were no significant differences in prevalence of purchasing between towns or between suburbs (Table 2), all being approximately 40–50%. Mirroring the collection results, the frequency of purchase was significantly higher ($U = 8.7$; $p < 0.01$) in winter (±2.9 times per month) than in summer (±1.6 times per month) (Table 3).

Fruits

Fruits collected on homesteads

Approximately half (48%) of all households collected fruits from their homesteads (Table 2). The prevalence of collection was higher among Tzaneen households (64%) than households in Bela Bela (39%) or Zeerust (41%). Considering all three towns, the prevalence of collection was greatest amongst township residents relative to the other two suburbs, but the pattern was variable within towns.

Residents in Tanzeen collected a greater number of fruit species (21) from their homestead than the 16 species recorded at Bela Bela and 14 at Zeerust. Over 90% of the households in the informal and township areas in Tzaneen harvested *Mangifera indica* (L.), whilst *Prunus persica* (L.) Stokes was the most commonly collected fruit species by households in Bela Bela and Zeerust (Table 4). Mean collection frequency was every one or two days when in season (Table 4), which was significantly more frequently than fruits collected elsewhere in the town (Table 5).

Fruits collected from other places

Although the bulk of fruit collection was from residents' own plots, fruits were also collected from other places, including neighbours', friends' and relatives' homesteads and wild fruits from the edges of towns. Fewer (33%) households collected fruits from other places than from homesteads (Table 3), with the most marked difference being amongst township residents. Collection from other places was higher in Bela Bela (55%) than in Tzaneen (33%) or Zeerust (11%). The most commonly collected fruits from other places included *Citrus sinensis* (L.) Osbeck and *Carica papaya* (L.) in Tzaneen, and *P. persica* and *C. sinensis* in Bela Bela and Zeerust (Table 5). Tzaneen had the highest number of fruit species collected from other places (20), followed by Bela Bela (15) and Zeerust (8).

Households in Zeerust collected fruits from other places significantly more frequently ($H = 69.0$; $p < 0.005$) than households in Tzaneen or Bela Bela. Comparing suburbs, collection frequency was highest by residents of the informal suburbs ($H = 16.0$; $p < 0.005$), with little difference between the township and RDP areas.

Fruits bought from traders and stores

In addition to fruits collected on homesteads and other places, nearly all households bought fruits from traders and commercial outlets (Table 2). The most commonly purchased fruits were *Malus domestica* Borkh., *C. sinensis* and *Pyrus pyrifolia* (Burm.) Nak.

Minor tree products

Use of the minor tree products was variable between resources as well as between and within towns, with few clear patterns (Table 6). Wood for fencing, building and utensils was the mostly widely sought after resource, with most of it purchased from traders, although there was some significant collection from urban places in Zeerust and to a lesser extent Bela Bela. Some households planted live fences/hedges rather than used wood, with the most common species being *Dodonaea viscosa* Jacq., *Tecoma stans* (L.) Juss. ex Kunth or *Ligustrum lucidum* W.T. Aiton. Herbal medicines were collected by 10% of the households, with the most common species being *C. limon* (L.) Burm.f., *M. indica*, *P. guajava* (L.), *S. guineense* Wall. and *S. birrea* subsp. *caffra*. Medicines were procured from homesteads, other places and bought, but the most common source in Tzaneen was from homesteads, whilst in Bela Bela and Zeerust is was most commonly from other places. Tree seed pods and flowers were hardly used at all, and there was also very little use of tree litter and leaves for compost or mulch other than in Tzaneen from own homesteads. There was extensive procurement of planting material from a variety of sources in both Tzaneen and

Table 5
Percentage of households collecting the top seven fruits from other places and mean (± sd) frequency per month (Comparing towns, unlike superscripts represent significant differences within columns.).

Town	Informal	(%)	RDP	(%)	Township	(%)
Tzaneen	*Citrus sinensis*	18	*Citrus sinensis*	18	*Citrus sinensis*	12
	Malus domestica	16	*Carica papaya*	16	*Litchi chinensis*	8
	Mangifera indica	14	*Mangifera indica*	16	*Carica papaya*	4
	Carica papaya	10	*Persea americana*	16	*Prunus persica*	4
	Litchi chinensis	10	*Malus domestica*	6	*Vitis vinifera*	4
	Persea americana	8	*Psidium guajava*	6	*Citrus limon*	2
	Pyrus pyrifolia	6	*Syzygium guineense*	4	*Persea americana*	2
	Mean freq./month	3.1 ± 4.8^{a}		1.8 ± 4.0^{a}		2.7 ± 6.4^{a}
Bela Bela	*Prunus persica*	52	*Prunus persica*	46	*Persea americana*	28
	Citrus sinensis	44	*Citrus limon*	32	*Citrus sinensis*	20
	Citrus limon	30	*Mangifera indica*	20	*Citrus limon*	16
	Mangifera indica	20	*Citrus sinensis*	20	*Prunus persica*	16
	Psidium guajava	14	*Psidium guajava*	16	*Mangifera indica*	6
	Persea americana	12	*Persea americana*	14	*Psidium guajava*	6
	Vitis vinifera	12	*Carica papaya*	10	*Carica papaya*	4
	Mean freq./month	4.9 ± 6.1^{b}		9.9 ± 11.5^{b}		4.9 ± 4.1^{b}
Zeerust	*Prunus persica*	4	*Prunus persica*	24	*Citrus sinensis*	4
			Citrus sinensis	6	*Citrus limon*	2
			Citrus limon	4	*Searsia lancea*	2
			Ficus sp.(Feiye)	4	*Vitis vinifera*	2
			Pyrus pyrifolia	4		
			Passiflora edulis	2		
	Mean freq./month	$13.2 \pm 0^{*}$		6.2 ± 10.1^{b}		9.6 ± 11.7^{b}

* Statistical test was not applicable because of low sample size.

Bela Bela, whereas in Zeerust it was mostly sourced by the newer residents (informal and RDP) from other urban spaces.

Household attributes and use of tree products

The PCA results display the relationships between the collection of firewood or fruits from either homestead plots or urban areas and various household attributes (Fig. 2). It clearly demonstrates that collection of firewood or fruits was influenced more by the town than by the suburb, and that collection of either resource from the homestead plot was not significantly correlated with any of the household attributes, whereas collection from urban spaces was. More specifically, there is a strong correlation with urban firewood collection and specific towns, being high in Zeerust and low in Tzaneen. There was also a positive relationship between urban firewood collection and poverty as indicated by the number of government social grants per household. In contrast, more wealthy households had a lower incidence of firewood collection from urban spaces. This is reflected in Fig. 2 by being opposite to the number of grants per household as well as positively associated with the level of education of the household head. There was a weak significant relationship between education level of the household head and total household income ($r^2 = 0.25$; $p < 0.00001$). On the other hand, collection of fruits in urban spaces was highest amongst

Table 6
Prevalence of use (% of households) of minor tree products sourced from different places by urban households in three different suburbs of three towns.

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
	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
	Wood for fencing	30	0	0	16	0	0	36	0	0
	Wood for hh utensils	6	0	0	4	0	0	86	92	98
Bela Bela	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
	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
	Wood for building	0	0	0	12	0	0	88	28	68
	Wood for fencing	0	6	8	28	22	18	38	36	10
	Wood for hh utensils	0	0	0	4	0	0	84	94	96
Zeerust	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
	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
	Wood for hh utensils	0	0	0	0	0	0	46	42	68

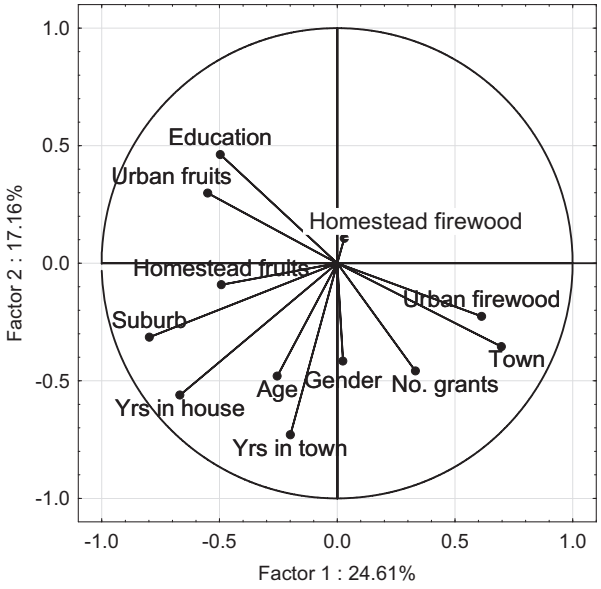

Fig. 2. PCA vector plot for collecting tree products and household attributes (lines projecting from the origin that are close to one another indicate potentially significant correlation between the two attributes, with long lines indicating stronger correlations than short lines. Diametrically opposite lines indicate potential negative correlations).

more educated and therefore presumably affluent households. This does not fit the suburb stereotype of the township households being more affluent and the data from Table 2, indicating that scale of analysis is instructive. There was an indication of a weak relationship between fruits collected from homestead plots and the suburb, being highest amongst township households. Other attributes such as gender or age of the household head and years of residency in the town or specific house had no influence on use of firewood or fruits collected on homesteads or urban spaces. The total variance accounted for by the first two axes of the PCA was 43%.

Discussion

It was evident that products from urban trees were important to the livelihoods of people in the sampled towns. Urban residents collected various consumptive tree products, including fruits, firewood, wood for building, fencing and utensils, planting material, herbal medicines, seed pods for decoration, mulch and compost. In Bangladesh Uddin and Hasan (2001) showed that households were collecting similar tree products on their homesteads. In Masvingo City (Zimbabwe), urban residents also collected various tree products from the edges of town (Murwendo, 2011). Cocks (2006) reported that 99% of urban households in two centres in South Africa made use of at least one wild plant species and that across a sample of 302 households 96 different species were recorded. Quantities used were significantly higher amongst poorer households. Considering all households in this study, collection of tree products from respondents' own homesteads ranged between 5 and 48%, while from other places, 1–53% and buying ranged between 0% and 100%. These proportions are similar (27–70%) to results reported by Davenport et al. (2011) regarding collection of wild products from commonages adjacent to three small towns. 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 lower income households were collecting tree products (firewood, wood for building and fencing) than higher incomes ones, as per our original hypothesis.

The households collected a wide range of tree products sourced from respondents' own homesteads, other places and bought from traders. Firewood and fruits were the most regularly collected, hence were categorised as major tree products and the remainder were labelled as minor tree products. Davenport et al. (2011) and Murwendo (2011) also found that firewood was collected by the majority of urban households. Collecting and use of tree products is a means of mitigating poverty because they are collected for free (Kalaba et al., 2009; Davenport et al., 2011).

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 of trees (Kaoma, 2012). This translated into a higher proportion of households using fruits and firewood as well as most of the minor products from their own homesteads than in the other two towns. However, the pattern was not consistent between Bela Bela and Zeerust. 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.

Analysis of intra-town patterns of tree use indicated that fruit harvesting from residents' own homesteads was most prevalent in the townships. These households were the least likely to collect wild fruits from other places. A similar pattern was observed for firewood, with more township households collecting firewood 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 have larger plots and were more established and therefore they had more trees from which to harvest or collect such products. However, the proportion of township residents using minor products was often lower than the RDP and informal residential areas. We 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 commercial alternatives. For example, they have fences of wire or walls of bricks rather than of locally obtained wood products. However, the prevalence of use does not reveal the whole story. When the frequency of use or actual amounts used, irrespective of source, were examined, then use by township households was typically lower than the RDP and informal residential areas, reflecting their relatively higher income status.

Overall, these results do not fit perfectly with our original hypothesis. Firstly, whilst we did find a strong effect of wealth on use, the PCA analysis showed that this was not correlated with the different suburbs as hypothesised. Indeed, the effect of town was greater than the effect of suburb. Secondly, the results show that a single hypothesis is unsuitable for multiple resources. The collection of both firewood and fruits from other places was correlated with household wealth and education, but in an opposite fashion; collection of firewood was more prevalent amongst poorer households than relatively affluent ones, whilst for fruits it was higher for more affluent households.

Firewood

Firewood was a major tree product used by urban residents. On average, a slightly higher proportion of all households were buying firewood (47.6%), followed by collection from other places and the least used source was from trees on homesteads. MEA (2005) reported that between 25% and 50% of households in South Africa use firewood, whereas we found 91% doing so, although not necessarily as their primary energy source. Households in the

informal residential area emerged as major buyers and collectors of firewood from other places, whereas more township residents were collecting from their own homesteads. Corroborating work has reported that poor urban households depend on firewood for heating and cooking (Brouwer and Falcão, 2004; Shackleton et al., 2007; Davenport et al., 2011). The number of households collecting or buying firewood varied from town to town and within each town. Tzaneen residents collected more from homesteads because there were many trees on their homesteads, and Zeerust, which had the least homestead trees (Kaoma, 2012), 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 firewood from homesteads because they had very small trees compared to the township and informal residential areas. Similar studies have reported that firewood can be sourced from trees within urban areas (Uddin, 2006; Fuwape and Onyekwelu, 2011). Some households deliberately pruned trees on their homesteads while others cut down trees during house expansion and use the wood for fuel. A few households collected dead wood for firewood from street trees. Fuwape and Onyekwelu (2011) and Uddin (2006) reported the same trends in West Africa and Bangladesh, respectively. Firewood was also collected from the edges of towns corroborating work from Botswana (Nkambwe and Sekhwela, 2006), South Africa (Davenport et al., 2011), West Africa (Fuwape and Onyekwelu, 2011) and Zimbabwe (Murwendo, 2011) showing that trees on the edges of towns are important source of firewood to urban households.

Residents of areas without electricity collected firewood more frequently than those in residential areas with electricity. Therefore, firewood 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 (Uddin, 2006; Shackleton et al., 2007; Openshaw, 2010). Given the lower reliability of electricity compared to firewood (Openshaw, 2010), a situation worsened by frequent tariff increases, firewood will continue contributing to the livelihoods of the urban poor.

As recorded elsewhere (MEA, 2005; Shackleton et al., 2007), significantly cooler temperatures in the winter months resulted in higher frequencies of firewood collection and purchase, which increased by 37% and 75%, respectively. The difference was lowest in Tzaneen (16%) which had the mildest winter temperatures. Poor housing materials and insulation are also a factor in increasing demand for firewood amongst the urban poor during winter (UN-Habitat, 2003).

Fruits

More households (48%) sourced fruits from the homestead plot than collected elsewhere (33%), whilst nearly all bought some fruits. Some households exchanged fruits with neighbours thereby building social networks and reciprocity. 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 (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 from homesteads (Alam and Masum, 2005; Winklerprins and de Souza, 2005; Ndaeyo, 2007). In addition, exotic fruits also dominated the species of bought fruits, with *M. domestica* and *C. sinensis* being the top two fruits.

A few households collected indigenous fruits, including *S. guineense, S. birrea* subsp. *caffra*, *Diospyros mespiliformis* Hochst. ex A. DC., *Searsia lancea* (L.f.) F.A. Barkley, *Ziziphus rivularis* Codd and *Ficus* sp., several of which have been reported in previous studies among rural communities (Shackleton and Shackleton, 2004; Shackleton et al., 2010). These fruits were collected in small quantities, relatively infrequently and mostly by children. A few households collected fruits from other places including the edges of towns. Murwendo (2011) also encountered lower percentages of urban households collecting wild fruits from the surrounding places. 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 nobody marketing them.

Contrary to the proposals of Shackleton (2006) and Kalaba et al. (2009) that urban fruits represent a potential income source for the urban poor, no household in this study collected indigenous fruits for sale, although a few (12%) in Tzaneen sold excess mango (*M. indica*) yields from their homestead gardens to processing factories. Murwendo (2011) noted the sale of wild harvested fruits in towns in Zimbabwe, but nevertheless argued that the main benefit was from cash saving through direct consumption rather than from income generation through sale.

Fruits are considered as an important nutritional source to poor urban households, providing many micronutrients and vitamins (Murwendo, 2011). Kalaba et al. (2009) stated that fruits are used to meet nutritional needs on a day to day basis or in times of risk. This demonstrated that fruits were an important source of food and contribute to food security of urban households, since urban poverty, malnutrition and food insecurity are increasing in urban households (Baker, 2008). Even though indigenous fruits were not highly favoured by urban households, most contain much higher percentages of vitamins than exotic fruits (Legwaila et al., 2011).

Minor tree products

The direct use of consumptive trees products by urban households extends beyond just firewood and fruits. Homestead plots do not supply much by way of quantity, but a significant proportion of households do make some use of homestead trees for these purposes. Collection from other urban spaces can be high in quantity and prevalence (Fuwape and Onyekwelu, 2011; Uddin, 2006). For example, more than half of the residents of the informal area in Zeerust collected wood for building and for fencing. More than 10% of households collected planting material from urban spaces and 5–20% collected herbal medicines from urban trees. With wide variation between suburbs and between towns it is not possible to generalise. But it is clear that harvesting such products is common in many towns of the developing world (Kayode, 2010; Madaleno, 2011; Murwendo, 2011). For example, Kayode (2010) recorded 62 tree species in homestead gardens across several towns in Ekiti State (Nigeria), of which 57 species had direct use benefits, minor uses of which included basketry fibres, chewing sticks, fodder, latex, medicines, oils, resins, stakes, and income from the sale of tree products.

Conclusion

This study has shown that urban residents collect a variety of tree products from different places, including homesteads, neighbourhoods, edges of towns and further afield, as well as buying them from traders. The most widespread use was of firewood and fruits, while some products (e.g. flowers and seed pods) are used by only a few households. The main source of firewood was trees on the edges of towns, whilst the most common source of collected fruits was from trees on homesteads. Confirming the original hypothesis, firewood use was greatest amongst poorer households and suburbs. The same applied for fruits collected outside of the home space. The increasing prevalence of fruit collection from

homestead plots (relative to public urban spaces) with increasing affluence indicates a decreasing reliance on the urban commons.

The high consumptive use of tree products by urban households requires that an adequate supply is available, especially in poor areas. The differences in the most prevalent sources for firewood and fruits suggest that policies need to consider both public and private spaces in promoting direct use benefits from trees. Typically, homestead gardens are too small to make a meaningful contribution to household firewood supply, and therefore public areas need to be managed to promote sufficient and sustainable supplies. In contrast, collected fruits were mostly sourced from homestead plots, and hence a primary strategy to promote supply would be to ensure that homestead plots are large enough to accommodate sufficient trees and that planting material is available.

Acknowledgement

HK and the field work were funded by SANPAD (project 10/58), for which we are grateful.

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