

Full Length Research Paper

The Tswana tshimo: A homegarden system of useful plants with a particular layout and function

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The Tswana tshimo (homegarden) is a model of sustainable resource management in South Africa. However, gardens of indigenous cultures are often considered to be spontaneous and disorganized. A reconnaissance survey of homegardens of the Batswana people in the North-West Province of South Africa examined the different use categories of garden plants, the indigenous and alien composition of garden floras, and determining whether a specific homegarden layout exist with tshingwana (micro-gardens) containing useful species. A floristic survey was conducted of 163 randomly selected tshimo's from three Batswana communities (deep rural, rural and peri-urban). A total of 525 useful plant species belonging to 105 plant families were recorded. These could be divided into four main plant use categories, namely 98 food, 91 medicinal, 281 ornamental and 49 structurally functional species (e.g. hedges), while six species had other uses. Deep rural and rural homegardens are characterized by a higher percentage of naturally occurring, indigenous useful plant species when compared to the predominantly alien flora of peri-urban areas. Deep rural and rural homegardens had a specific garden layout that was characterised by six micro-gardens, namely food gardens, medicinal gardens, ornamental gardens, structural species, open areas and natural areas. In contrast, peri-urban Batswana gardens had a garden layout similar to European gardens.

Key words: Biodiversity, communal gardens, ethnobotany, Ganyesa, Ikageng, Tlhakgameng, urban greening, urban domestic garden.

INTRODUCTION

Since the ground-breaking paper by Fernandes and Nair (1986) to bring homegarden systems to the fore, and followed by a paper of Jose and Shanmugaratnam (1993) which proposed these systems to be of an ecological nature, a plethora of papers have dealt with homegardens during the last two decades. Homegardens are regarded as a type of domestic garden; 'domestic' derives from the Greek domos, meaning 'house'. There are many types of domestic gardens which vary in how intensively they are cultivated and their location with regard to the home. Generally, and from an urban perspective, a domestic garden is considered as luxury space around the house used for relaxation, play areas,

keeping pets, outdoor eating and the cultivation of ornamental plants. The difference between urban and rural gardens, however, lies in the purpose and use. Homegardens are often used for similar functions as urban domestic gardens, but based on their association with developing countries, their main purpose is to support livelihoods, primarily food production, medicine and spirituality (Alvarez-Buylla et al., 1989; Das and Das, 2005; Nemudzudzanyi et al., 2010).

A homegarden is an intensively worked land-use system involving deliberate management of multipurpose plants in association with agricultural crops, and invariably livestock, within the compounds of individual households (Fernandes and Nair, 1986). The uses of homegardens vary, as some are used for subsistence agriculture and others for the commercial production of food crops (Vogl et al., 2004). In the rural homegarden, gardeners usually grow fruit, vegetables, medicinal,

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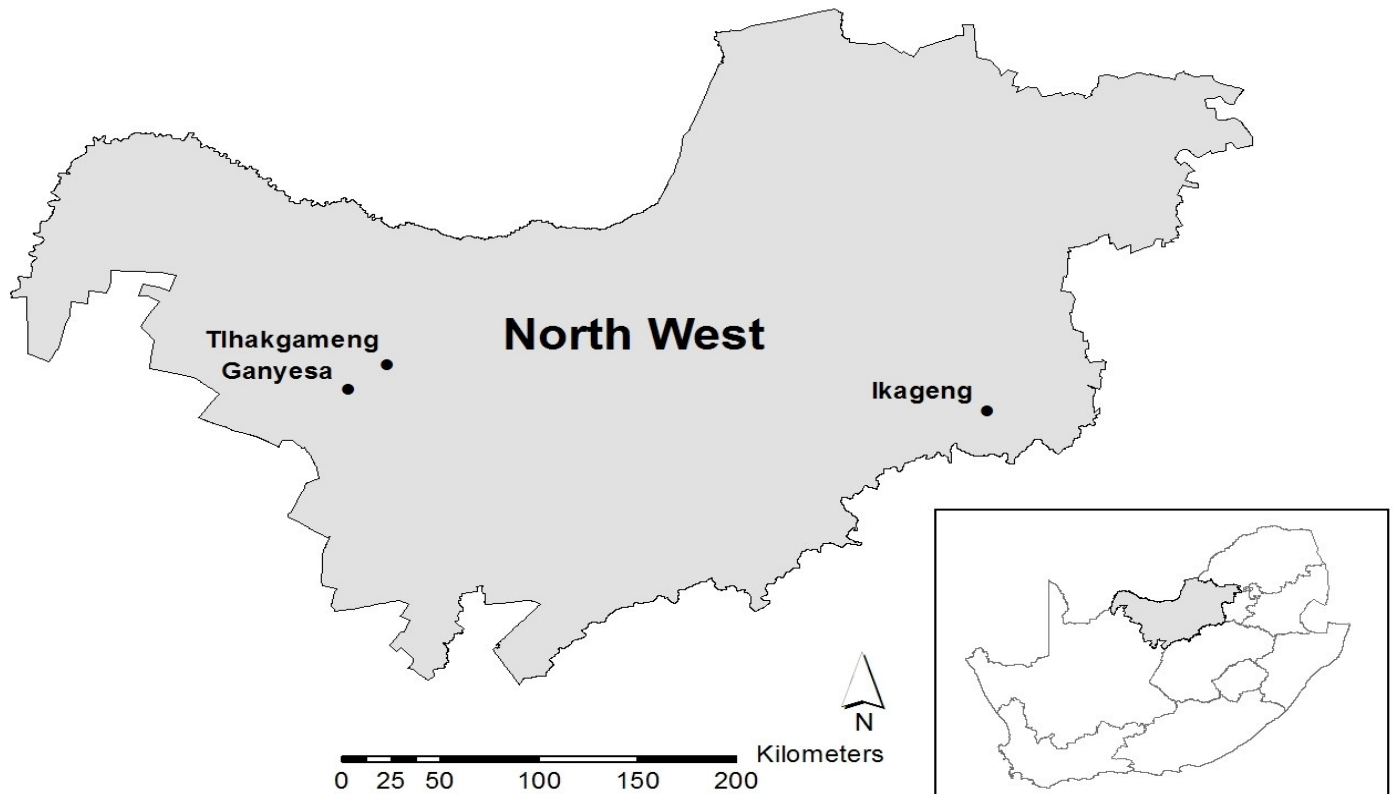


Figure 1. Locality of the study areas in North-West Province, South Africa: Ikageng, peri-urban; Ganyesa, rural; Tlhakgameng, deep rural.

spiritual and ornamental plants (Lamont et al., 1999; Kumar and Nair, 2004). In developing countries, homegardens are mainly kept as a way of supplementing the cereal-based diet of rural households and few gardeners have the objective to increase household income (Ruel, 2001), but merely to save on food expenditure (Martin et al., 2000). These gardening systems play an essential role in food and health security (Allen, 1999).

Homegardens preserve cultural history, as many useful plant species have been subjected to intense human management regimes on such sites over extended periods. Throughout time, farmers have cultivated and selected desired plants, and in this way, homegardens have become genebanks of current and potential resources (Alvarez-Buylla et al., 1989), as well as sites for domestication of useful plant species (Hawkes, 1983). In Africa, indigenous useful plants require minimum production input and people know how to cultivate and prepare these based on dynamic indigenous knowledge systems (IKS). Such an example is African leafy vegetables, which grow quickly, are relatively drought tolerant, often cultivated without pesticides, and can be harvested within a short period of time from soils of limited fertility (Shiundu, 2002).

The purpose of this study was to document, characterise and compare the diversity of useful plants in

deep rural, rural and peri-urban homegardens of a single ethnic group, the Batswana of the North-West Province, South Africa. The focus was on creating a database of intentionally planted and/or retained and managed useful plant species from homegardens, which creates a basis from which to indirectly assess whether urbanisation has an effect on garden floras within a single culture. By studying floristic changes within a single culture, the bias of preference for specific plants is ousted; a situation quite common in South Africa's racially segregated communities (Mabin, 1992). The specific objectives of this study were to (1) evaluate the composition of the flora in terms of indigenous or alien origin, (2) examine the different use categories of homegarden plants, and (3) determine whether placement of micro-gardens is linked to a specific garden layout in homegardens of the Batswana.

MATERIALS AND METHODS

Study area

The study was conducted in the deep rural setting of Tlhakgameng, rural setting of Ganyesa and peri-urban setting of Ikageng in North-West Province, South Africa (Figure 1). Deep rural was defined as an inhabited area where tribal authority manages the community and 90% of the inhabitants are subsistence farmers. Rural is

Table 1. Proportion (%) of the flora of homegardens contributing to each of the plant-use categories and sub-categories.

Micro-garden	Deep rural (Tlhakgameng)	Rural (Ganyesa)	Peri-urban (Ikageng)	Total
Useful plant species(n)	294	314	296	525
Total % ornamental plants	46	47	60	54
Fruit trees	7	7	6	5
Grain	4	3	2	3
Fruit vegetables	4	4	4	5
Leafy vegetables	6	5	9	6
Total % food plants	21	19	21	19
Total % medicinal plants	20	22	12	17
Hedge	3	3	1	2
Windbreak	2	2	1	2
Shade	7	6	4	5
Total % structural plants	12	11	6	9
Total % other uses	1	1	1	1

defined as an inhabited area under municipal management, where less than 50% of the inhabitants are subsistence farmers. Peri-urban is an inhabited area on the fringes of a city that falls under the management of a city council, and less than 10% of the inhabitants are subsistence farmers.

North-West Province was chosen as a model study site to test our hypothesis. Firstly, it has a well-documented cultural history of plant usage and Indigenous Knowledge Systems (Grivetti, 1979; Ntamu, 1996). Secondly, it is close (200-300 km) to the main metropolitan area of Gauteng, which provides access to a variety of plant resources. Thirdly, it falls in the semi-arid climatic zone of South Africa (400-600 mm per annum) with winter temperatures that can drop to -7°C (Mucina and Rutherford, 2006), all which makes for careful selection of horticultural species.

For the purpose of this study a homegarden (tshimo) was defined as a land-use form on private or communal land surrounding an individual house (ntlo) with a definite fence as border around the yard (patlelo), in which several useful tree species are cultivated together (intercropped) with crops and other useful plants; often with the inclusion of small livestock.

Sampling, data collection and analysis

The survey of homegardens was undertaken in 2008 and 2009. Within the pool of available residences, 163 homegardens were selected for comparative purposes, 51 gardens were randomly selected from several localities in the deep rural town of Tlhakgameng, 61 from localities in the rural town of Ganyesa and 51 from the peri-urban area of Ikageng (suburb of the Tlokwe municipality). Homegardens were randomly sampled, ensuring a minimum distance of 500 m apart. Sampling took place in plots of 20 x 20 m (400 m²) which has been shown to be a representative sample (Davoren 2009). The mean yard size was recorded as 1600 m² and the mean size of the cultivated areas were 1000 m².

In each garden, the coordinates, household age, yard size and various microgardens (such as food and medicinal gardens) were documented. A checklist of all vascular plant taxa in each homegarden was compiled. Species were included in the checklist if the gardener could indicate a use for the plant. Species were differentiated into indigenous (native), cultivated indigenous, naturalized alien or cultivated alien species.

These categories are defined as follows:

- (i) Indigenous - naturally occurring within the study area (native to the area), usually not cultivated;
- (ii) Indigenous cultivated - indigenous to South Africa and not occurring naturally within the study area (not native to the area), but cultivated in gardens;
- (iii) Naturalised alien - not indigenous to South Africa, but occurs in the study area where it sustains self-replacing populations outside of cultivation without direct intervention by people;
- (iv) Cultivated alien - not indigenous to South Africa and not naturalised in the study area, but cultivated in gardens and including garden hybrid species.

Identification was done up to the species level, with infraspecific taxa being merged into species. Duplicate specimens of taxa were identified by the Pretoria National Herbarium (PRE) and the AP Goossens Herbarium (PUC). Identification was aided by prominent literature (Bromilow, 1995; Van Wyk et al., 1997; Pienaar, 2000; Van Wyk and Gericke, 2000; Henderson, 2001; Glen 2002; Van Wyk, 2005), which also provided information on indigenous, alien, cultivation and use categories.

Plant species present in surveyed gardens were categorized according to their uses while their positions within the garden were noted, namely as situated in one of six main Tswana microgardens: food, medicinal, ornamental, functional, open area and natural area (Davoren, 2009). The occurrence of species was calculated as the percentage of homegardens in which a species was recorded. Micro-garden positions in gardens were determined where groups of species within a specific position were repeated for > 50% of the gardens; and therefore mappable.

RESULTS

Species richness and diversity

A total of 525 useful plant species were recorded from 163 homegardens in Ganyesa, Ikageng and Tlhakgameng (Table 1). Gardens of deep rural areas had 39 ± 18 species recorded on average per garden (294 useful species), versus the 35 ± 16 per garden for rural

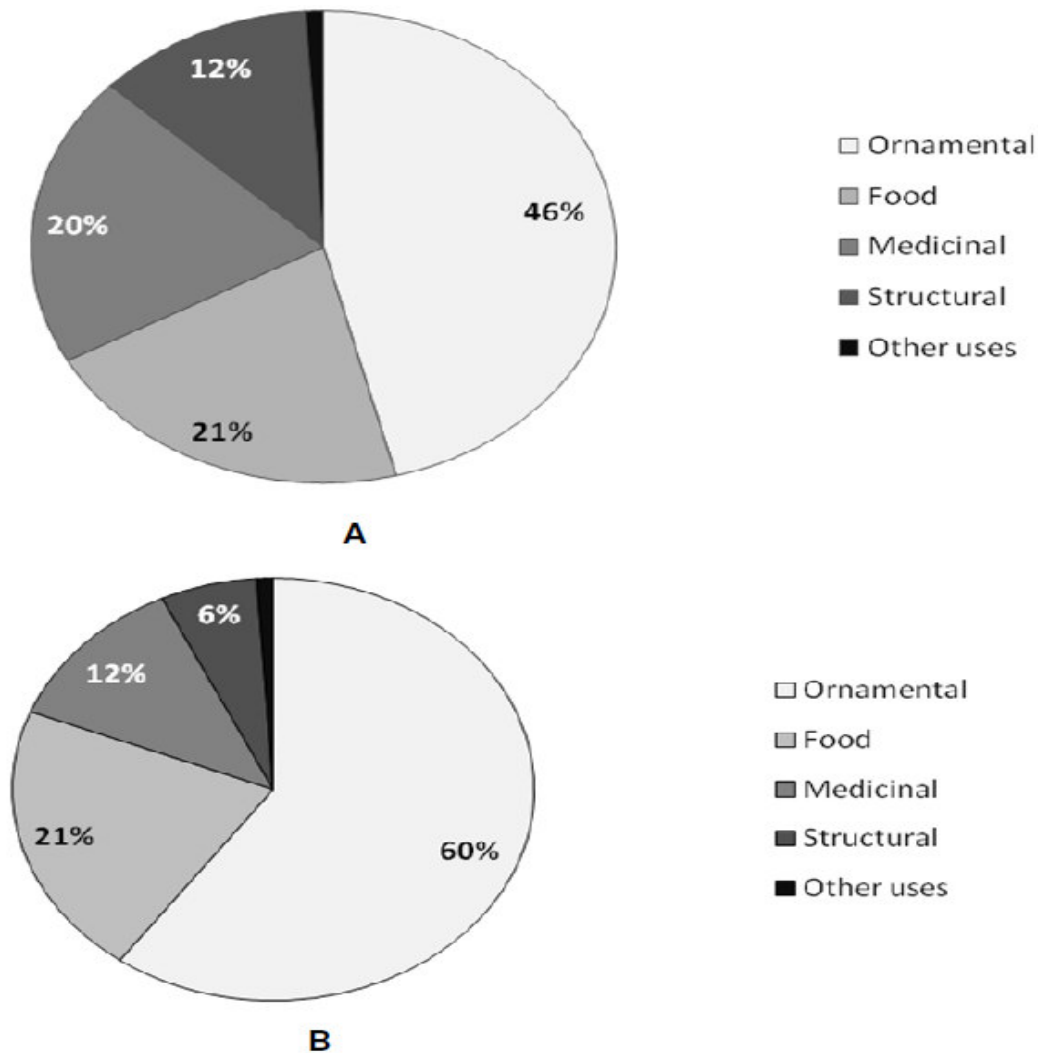


Figure 2. Contribution (%) of each of the five plant-use categories towards the flora of Tswana homegardens in: A, Tlhakgameng (deep rural) & Ganyesa (rural); B, Ikageng (peri-urban).

(314 useful species) and 25 ± 10 per garden for peri-urban areas (296 useful species). The number of species for the entire garden flora of deep rural areas (391 species) did not differ much from rural (399 species) and peri-urban areas (382 species). However, only 34% of the species found in homegardens of deep rural areas were not recorded for rural homegardens, but 56% of deep rural species were not recorded for peri-urban gardens. This discrepancy is further supported by the frequency of occurrence of useful plants, with 1,980 individuals (of 294 species) indicated as useful by 51 gardeners from deep rural areas and 2,323 individuals (of 314 species) from 61 rural gardens, but in contrast only 1 276 individuals (of 296 species) in 51 peri-urban gardens.

In deep rural gardens 73% of useful plant species are cultivated and 27% occur naturally. Deep rural gardens have 20% of species occurring in what is termed a 'veld garden', hence the high percentage of naturally

occurring, useful plant species. In contrast, 78% of useful plants in rural gardens and 81% in peri-urban gardens are cultivated. Useful species can be grouped into plant-use categories, and for deep rural, rural and peri-urban gardens $\pm 20\%$ of the plant diversity represent food plants (Figure 2). Interestingly, peri-urban areas had the highest percentage of leafy vegetables (9%) in homegardens (Table 1). The flora of deep rural and rural homegardens contained $\pm 20\%$ medicinal plants (Figure 2). In contrast, medicinal plants only contributed 12% of the peri-urban garden flora. This lower percentage could be ascribed to the 60% ornamental plant species present in peri-urban gardens (Figure 2). Deep rural and rural homegardens are also dominated by ornamental species, but considerably less than peri-urban areas, namely 46 and 47%, respectively.

Peri-urban homegardens also have less structural species, namely hedges, windbreaks and shade trees,

Table 2. List of the 30 most frequently recorded useful plant species from Batswana homegardens in North-West, South Africa, in descending order (n=163; >25% F (frequency)). Plant use: Fr, fruit; Gr, grain; He, hedge; Me, medicinal; Or, ornamental; Sh, shade; Ve, vegetable.

Species	Vernacular name	Plant use	F
<i>Cynodon dactylon</i> (L.) Pers.	Couch Grass	Or	94
<i>Schkuhria pinnata</i> (Lam.) Cabrera*	Dwarf Mexican Marigold	Me	66
<i>Prunus persica</i> (L.) Batsch.*	Peach	Fr	65
<i>Portulaca oleracea</i> L.*	Purslane	Ve	60
<i>Mollugo cerviana</i> (L.) Ser. ex DC.	Sandy carpetweed	Me	48
<i>Sida cordifolia</i> L.	Flannel weed	Me	48
<i>Felicia muricata</i> (Thunb.) Nees	White Felicia	Me	40
<i>Zea mays</i> L.*	Maize	Gr	38
<i>Ficus carica</i> L.*	Common Fig Tree	Fr	37
<i>Vitis vinifera</i> L.*	Grape	Fr	37
<i>Schinus molle</i> L.*	Pepper Tree	Sh	37
<i>Bidens bipinnata</i> L.*	Spanish Blackjack	Ve	37
<i>Dodonaea viscosa</i> Jacq.	Sand Olive	He	36
<i>Bulbine abyssinica</i> A. Rich.	Bushy Bulbine	Me	36
<i>Eleusine coracana</i> (L.) Gaertn.	African Goosegrass	Gr	35
<i>Ziziphus mucronata</i> Willd.	Buffalo Thorn	Me	35
<i>Morus alba</i> L.*	White Mulberry	Fr	34
<i>Acacia hebeclada</i> DC.	Candle Thorn	Me	34
<i>Nerium oleander</i> L.*	Oleander	Or	33
<i>Amaranthus viridis</i> L.*	Slender Amaranth	Ve	32
<i>Cynodon hirsutus</i> Stent	Red Quick Grass	Or	32
<i>Verbena encelioides</i> (Cav.) Benth. and Hook.*	Wild Sunflower	Or	32
<i>Cucurbita pepo</i> L.*	Marrow	Ve	31
<i>Senna italica</i> Mill.	Black Storm	Me	31
<i>Citrullus lanatus</i> (Thunb.) Matsum. & Nakai	Wild Watermelon	Ve	29
<i>Vigna unguiculata</i> (L.) Walp.	Cowpea	Ve	27
<i>Pollichia campestris</i> Aiton	Waxberry	Fr	26
<i>Catharanthus roseus</i> (L.) G. Don.*	Madagascar Periwinkle	Me	26
<i>Rosa chinensis</i> Jacq.*	Fairy Rose	Or	26
<i>Euphorbia inaequilatera</i> Sond.	Smooth Milkweed	Me	26

than the 12% of deep rural and rural areas (Figure 2). The Tswana homegardens of North-West have a core of 30 diagnostic species that occur in more than 25% of the 163 surveyed gardens (Table 2), with a mean number of 12±4 of these species occurring per sample plot. The five largest families recorded from the homegardens were the Asteraceae (85 species), Poaceae (54 species), Fabaceae (52 species), Solanaceae (26 species) and Lamiaceae (22 species). Other large families represented by 15-20 species of the garden flora are the Amaryllidaceae, Asphodelaceae, Crassulaceae, Malvaceae and Rosaceae.

Food crops

Cultivated food crops constitute 19% of the species in Tswana homegardens (Table 1). Although, different types

of food crops occur, 70 species were recorded. Only 20-30% of these species are indigenous (Figure 3). Food plants include 24 vegetables, 28 leafy vegetables, four tubers, three fodders, and 11 grains. *Zea mays** (Maize) was the most dominant cereal crop, and as a staple diet was found in 38% of the gardens. Food crops were generally grown as a monoculture or intercropped with others (e.g. *Z. mays* together with *Vigna unguiculata* (Cowpea) or *Citrullus lanatus* (Watermelon)). Leafy vegetables and grains are grown in clearly demarcated vegetable micro-gardens.

Ten food plant species each occurred in more than 20% of the Tswana homegardens, namely the vegetables *C. lanatus*, *Cucurbita pepo** (Marrow), *Lycopersicon esculentum** (Tomato), *Pollichia campestris* (Waxberry) and *V. unguiculata*, the leafy vegetables *Amaranthus viridis** (Slender Amaranth), *Bidens bipinnata** (Spanish Blackjack) and *Portulaca oleracea** (Purslane), and the

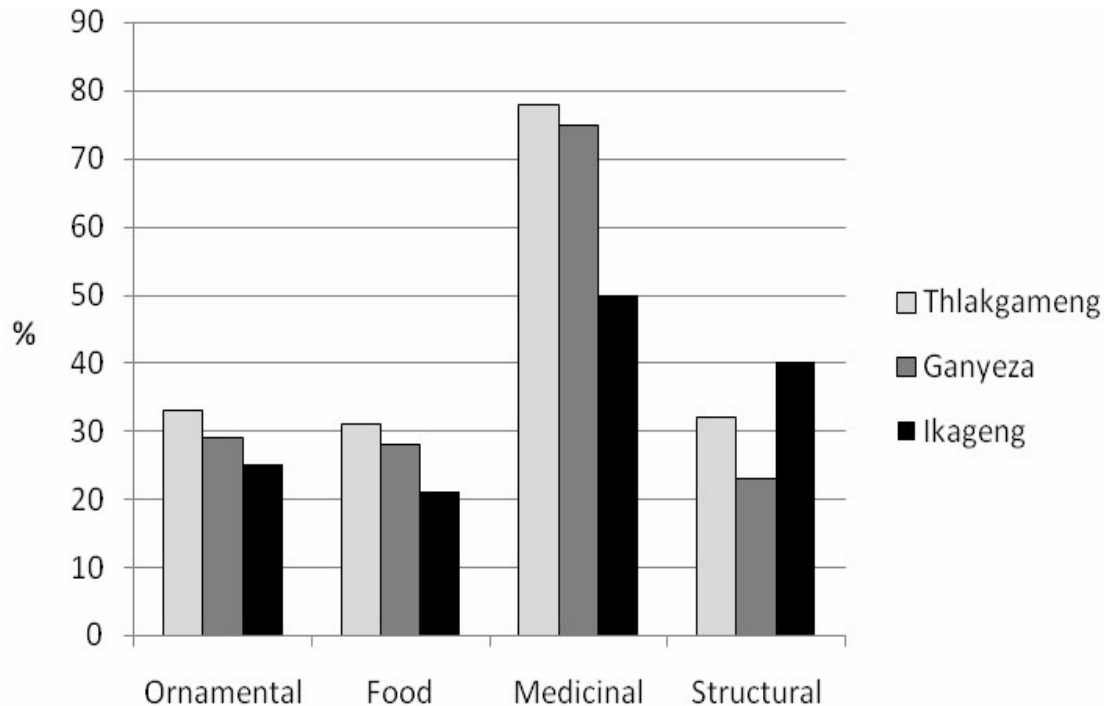


Figure 3. Percentage of indigenous species within each of the main plant use categories identified for the Tswana homegardens of North-West Province.

grains *Eleusine coracana* (African Goosegrass) and *Z. mays**. On average, approximately 11 ± 6 different food plants were encountered per deep rural homegardens, compared to the lower 8 ± 4 species for both rural and peri-urban homegardens.

Fruit trees

The richness of fruit trees, which also includes species with medicinal uses, warrants that the results are described here separately. Fruit trees are grown in mixed stands (orchards) and in most cases behind the house. Generally, more than half of fruit trees recorded from orchards are exotic, with 15% of fruit trees in Tswana homegardens being naturally occurring indigenous species. This is best illustrated by *Grewia flava* (Velvet Raisin Bush) that is found naturally as mature, fruit-bearing individuals in 20% of deep rural and rural homegardens, but is nearly completely absent from peri-urban gardens (2%). As the orchards are dominated by exotic aliens, some species that are declared as invasive aliens by South African law occur frequently, namely *Eriobotrya japonica** (Loquat), *Morus alba** (White Mulberry) and *Opuntia ficus-indica** (Prickly Pear).

Six fruit trees occur in more than 20% of the Tswana homegardens, namely (in descending order of frequency) *Prunus persica** (Peach), *Vitis vinifera** (Grape), *Ficus carica** (Common Fig Tree), *Morus alba**, *Prunus armeniaca** (Common Apricot) and *Punica granatum**

(Pomegranate). In terms of frequency of occurrence, 211 individual fruit trees have been recorded from 51 deep rural homegardens, 216 from 61 rural gardens and 90 from 51 peri-urban homegardens. This suggests that on average, every orchard is made up of three fruit trees, with orchards being the largest in deep rural areas (four trees per orchard on average).

Medicinal plants

Medicinal plants constitute 17% of all the useful plant species recorded for the 163 Tswana homegardens (Table 1), and consists mainly of forbs (22 annual, 33 perennial and 13 geophytic species), 18 shrub species and five tree species, namely *Acacia erioloba* (Camel Thorn), *A. karroo* (Sweet Thorn), *Erythrina lysistemon* (Common Coral Tree), *Olea europaea* subsp. *africana* (Wild Olive) and *Ziziphus mucronata* (Buffalo Thorn). Medicinal plants are found throughout the garden, but are most often grouped in small gardens (tshingwana). Deep rural gardens account for 59, rural gardens for 69 and peri-urban gardens for 36 medicinal species. Most of the species (>70% of the cases in deep rural and rural areas) were indigenous (Figure 3). However, when considered separately, 50% of medicinal plants in peri-urban gardens are exotic aliens (Figure 3), compared to the 22 and 25% of deep rural and rural homegarden floras respectively.

Ten medicinal species occurred in more than 20% of the homegardens, namely (in descending order of

frequency) *Felicia muricata* (White Felicia), *Bulbine abyssinica* (Bushy Bulbine), *Ziziphus mucronata*, *Acacia hebeclada* (Candle Thorn), *Senna italica* (Black Storm), *Catharanthus roseus** (Madagascar periwinkle), *A. karroo*, *Gisekia pharnacioides* (Ostrich Grape), *Acrotome inflata* (Tea Bush) and *Artemisia afra* (African Wormwood). These species are most commonly used to treat diarrhea, fever and pain. In terms of frequency, 610 individual medicinal plants have been recorded from deep rural, 563 from rural and 248 from peri-urban homegardens. On average, approximately 12 ± 3 and 11 ± 4 different medicinal plant species were encountered per deep rural and rural homegardens respectively, compared to the low 5 ± 2 species per peri-urban homegarden.

Ornamental plants

Ornamental plants constitute 54% of all plant species recorded for the 163 Tswana homegardens (Table 1), and consist mainly of forbs (27 annual, 82 perennial, 26 geophytic and 47 succulent species), 17 climbers, 55 shrubs and 27 trees. Ornamental plants are found throughout the garden, but are most often grouped together in flowerbeds. Deep rural gardens are decorated from a species pool of 136, rural gardens from 144 and peri-urban gardens from 178 ornamentals. Most of the species (70% of the cases) were cultivated aliens. However, when considered separately, 33% of ornamental plants in deep rural gardens are indigenous, compared to the 29 and 25% of rural and peri-urban homegarden flora respectively (Figure 3).

Nine ornamental species occurred in more than 20% of the homegardens, namely (according to growth form in descending order of frequency) the grasses *Cynodon dactylon* (Couch Grass) and *Cynodon hirsutus* (Red Quick Grass), the annuals *Verbesina encelioides** (Wild Sunflower) and *Tagetes erecta** (African Marigold), the perennials *Portulaca grandiflora* (Moss Rose), *Pelargonium hortorum* (Pelargonium) and *Canna indica** (Indian Shot), and the shrubs *Nerium oleander** (Oleander) and *Rosa chinensis** (Fairy Rose). On average, approximately 11 ornamental plant species were encountered per homegarden for all three study sites.

Functional plants: hedges, windbreaks and shade trees

Since a number of plants, especially trees, have multiple uses, this section represents species where gardeners have specifically stated that their use is of a structural nature and not for any other purpose. Hence, three uses fall exclusively in this category, and are present in more than 80% of deep rural and rural homegardens.

Peri-urban gardens have less than 50% of the total number of species used as shade trees or hedges in Tswana homegardens. Furthermore there is a dramatic decrease of windbreaks in peri-urban areas and only one species, *Arundo donax** (Giant Reed), is used for this purpose. Hedges are popular in deep rural and rural homegardens, and *Dodonaea viscosa* (Sand Olive) is planted extensively in these areas (65 and 41% of respectively). In contrast, *Ligustrum lucidum** (Chinese Privet), is planted as a hedge in 57% of peri-urban homegardens, despite it being a declared invasive alien species in South Africa. Overall, the majority of species in this category are alien species (>50%) (Figure 3) and all species cultivated as windbreaks are aliens.

Ten species of structural use occurred in more than 20% of the homegardens, namely (in descending order of frequency) *Acacia tortilis* (Umbrella thorn), *Melia azedarach** (Syringa Berry), *Prosopis glandulosa** (Honey Mesquite), *Searsia lancea*, *S. pendulina* (White Karree) and *Schinus molle** (Pepper Tree) as shade trees, *Dodonaea viscosa* and *Ligustrum lucidum** as hedges, and *Arundo donax** and *Casuarina cunninghamiana** (Beefwood) as windbreaks. On average, approximately four plant species are used for structural purposes per garden in deep rural and rural homegardens, compared to only one species per peri-urban homegarden.

Micro-gardens

Food gardens are diverse and are divided into two subtypes, namely orchards (fruit trees; e.g. *P. granatum** (Pomegranate)) and vegetable gardens. Vegetable gardens are divided into intercropping sections to cultivate grains (e.g. *Sorghum bicolor* (Grain Sorghum)), leafy vegetables (e.g. *Cleome gynandra* (Spider Wisp)) and vegetables bearing fruit (e.g. *C. pepo** (Marrow)). Medicinal gardens are characterised by different medicinal species being planted and managed within a single clump, usually close to the house (e.g. *A. afra* (African Wormwood)).

Ornamental gardens are comprised of four subtypes, the main type being flower beds (e.g. *V. encelioides**) that hold a large diversity of aesthetic species. Lawns, constituting areas planted with grass species (e.g. *Pennisetum clandestinum** (Kikuyu Grass)) that are regularly cut, are common where irrigation is available. Species of special value, or which might require special treatment due to harsh conditions, are planted in containers. Pots are often used, in the more urbanised environment, to hold shade and water loving plants (e.g. *Drimiopsis maculata* (Spotted-leaved Drimiopsis)) and are kept on verandas. The rural and deep rural homegardens are characterised by containers constructed from sand and water mixtures and are positioned near the main entrance gate of the homegarden. These structures are specifically used to grow succulents for spiritual

Table 3. Occurrence of micro-gardens in Tswana homegardens as a percentage of the number of gardens recorded for Tlhakgameng, Ganyesa and Ikageng. [Numbering corresponds to numbered positions on the garden layout plan (Figure 4)].

Micro-gardens (tshingwana)	Tlhakgameng (n=51)	Ganyesa (n=61)	Ikageng (n=51)
1. Food:			
Orchard	82	72	52
Vegetable	73	79	54
2. Medicinal	38	36	18
3. Ornamental:			
Flower beds	75	84	96
Containers	43	56	78
Succulent containers	73	57	39
Lawn	51	65	100
4. Structural:			
Windbreak	39	62	2
Fire screen	82	68	13
Shade	98	84	59
Hedge	78	67	64
5. Open area (lebala)	100	84	71
6. Natural area (naga)	84	66	6

purposes (e.g. *Cotyledon orbiculata* (Pig's Ear)).

Functional gardens have four subtypes and these are not species rich, but contain key species that are cultivated for a specific service. Windbreaks (e.g. *Casuarina cunninghamiana** (Beefwood)) are often grown along vegetable gardens and houses to protect the crops and inhabitants from the sand-laden Kalahari winds in Tlhakgameng and Ganyesa. Fire screens, made from branches, are commonplace in areas without electricity and protect the outside cooking area from wind. These screens are constructed by planting quick growing species (e.g. *Atriplex nummularia** (Old Man Saltbush)) close together for density. Shade trees (e.g. *Searsia lancea* (Karree)) are frequently found in the poorer, rural areas where there are no luxuries like outdoor patios and indoor cooling. It is also the meeting place for people from the more traditional environs (ubuntu concept).

Open areas around the house are of cultural significance (lebala concept) and are extensively swept and weeded (e.g. *Mollugo cerviana* (Sandy Carpetweed)), and the responsibility of the daughter-in-law. Small patches of natural areas are found in especially deep rural, but also rural areas (e.g. *Eragrostis lehmanniana* (Lehmann's Lovegrass)). These areas serve as short-term grazing for animals to be milked or slaughtered, or a place where useful indigenous plant species are collected for household purposes (naga concept).

Garden layout

Peri-urban homegardens (n=51) showed no specific pattern or existence of tshingwana (micro-gardens).

Useful plants are generally scattered throughout the yard in three main micro-gardens, namely flower beds, vegetable gardens and lawns. The most frequently occurring micro-gardens were lawns (100% of gardens), flower beds (96%), pots (78%), open areas (71%) and hedges (64%) (Table 3). Vegetable gardens were found in 54% of gardens, but medicinal gardens only in 18% (Table 3).

Rural homegardens (n=61) revealed a specific pattern and occurrence of micro-gardens. Five micro-gardens occurred in more than 70% of the homegardens, namely shade trees, flower beds, open areas, vegetable gardens and orchards (Table 3). Vegetable gardens were recorded for 79% of homegardens, which is higher than deep rural areas. Containers (made from sand) planted with succulents were found as regularly as pots (Table 3). Medicinal gardens were recorded for a third of the homegardens only.

Deep rural homegardens (n=51) revealed a definite pattern, occurrence and placement of micro-gardens. Five micro-gardens occurred in more than 80% of homegardens, namely open areas, shade trees, natural areas, orchards and fire screens (Table 3). Nine micro-gardens were recorded for more than 70% of the homegardens. Containers planted with succulents were found in 73% of homegardens and are kept for spiritual purposes. Windbreaks (39%) were less common than expected, especially when compared to the high occurrence in rural gardens. Medicinal gardens were the most frequent for deep rural areas, occurring in 38% of homegardens (Table 3).

The garden layout of a typical Tswana tshimo was constructed based on the occurrence of micro-gardens and their sub-types in similar positions in more than 50%

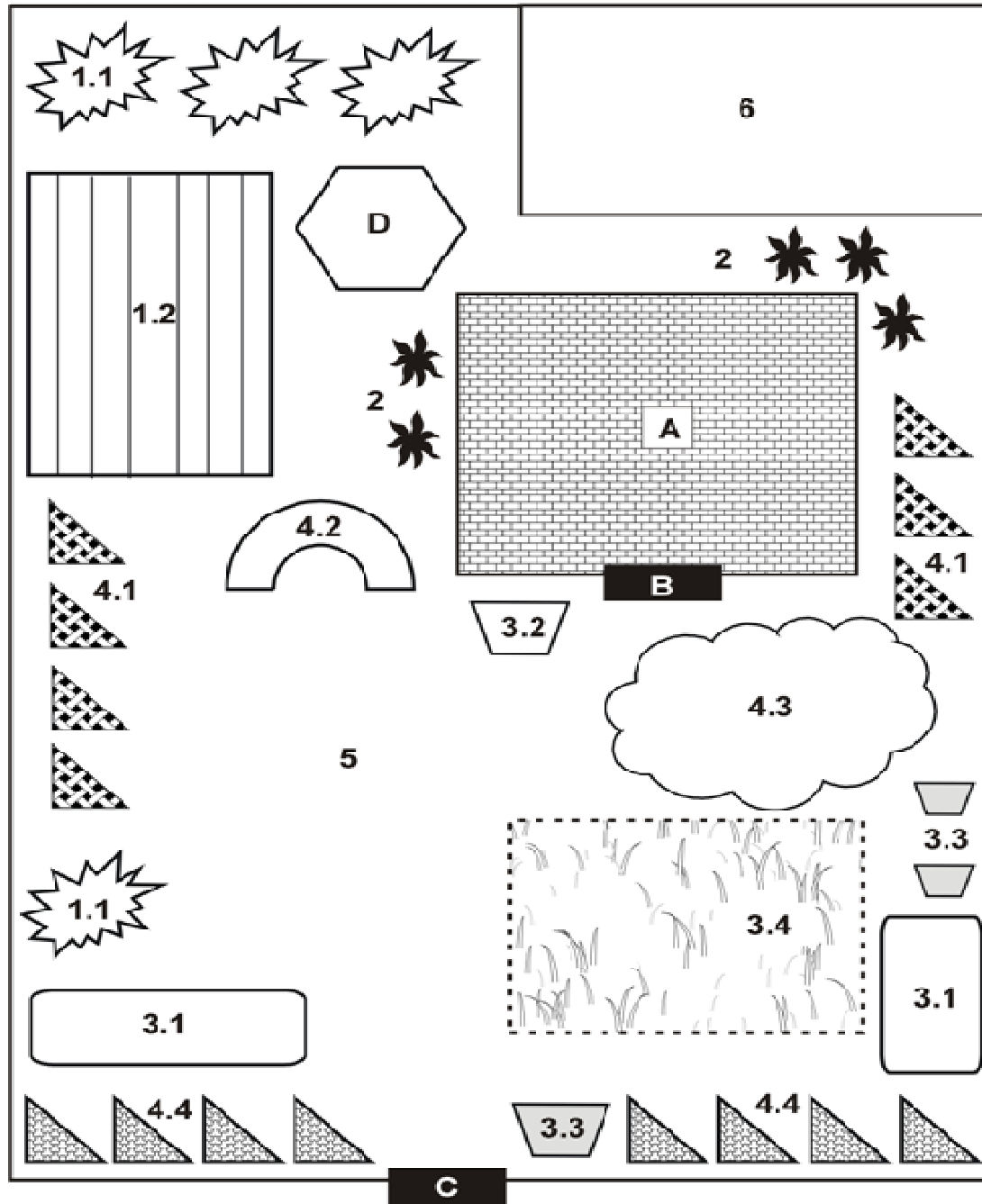


Figure 4. General garden layout of a Tswana tshimo (homegarden) based on the occurrence of micro-gardens in more than 50% of the cases ($n=102$). Key to the map: A, position of the house; B, front door of house; C, main entrance gate; D, livestock holding pen; 1.1, orchard; 1.2, vegetable garden; 2, medicinal garden; 3.1, flower bed; 3.2, container; 3.3, succulent container; 3.4, lawn; 4.1, windbreak; 4.2, fire screen; 4.3, shade tree; 4.4, hedge; 5, open space (lebala); 6, natural area (naga). Drawing not according to scale.

of the homegardens (Figure 4). Medicinal gardens were also indicated despite low frequencies of occurrence. The front door and main gate entrance were included for orientation, and the position of micro-gardens were mapped in relation to these markers. Medicinal gardens, windbreaks and natural areas had the lowest occurrence,

but open areas, flower beds and shade trees were frequently encountered and easy to allocate to a specific position. In most cases the positions were based on homegarden layouts from deep rural areas, except for lawns, pots and windbreaks that were based on data from rural areas. Peri-urban areas were westernized and

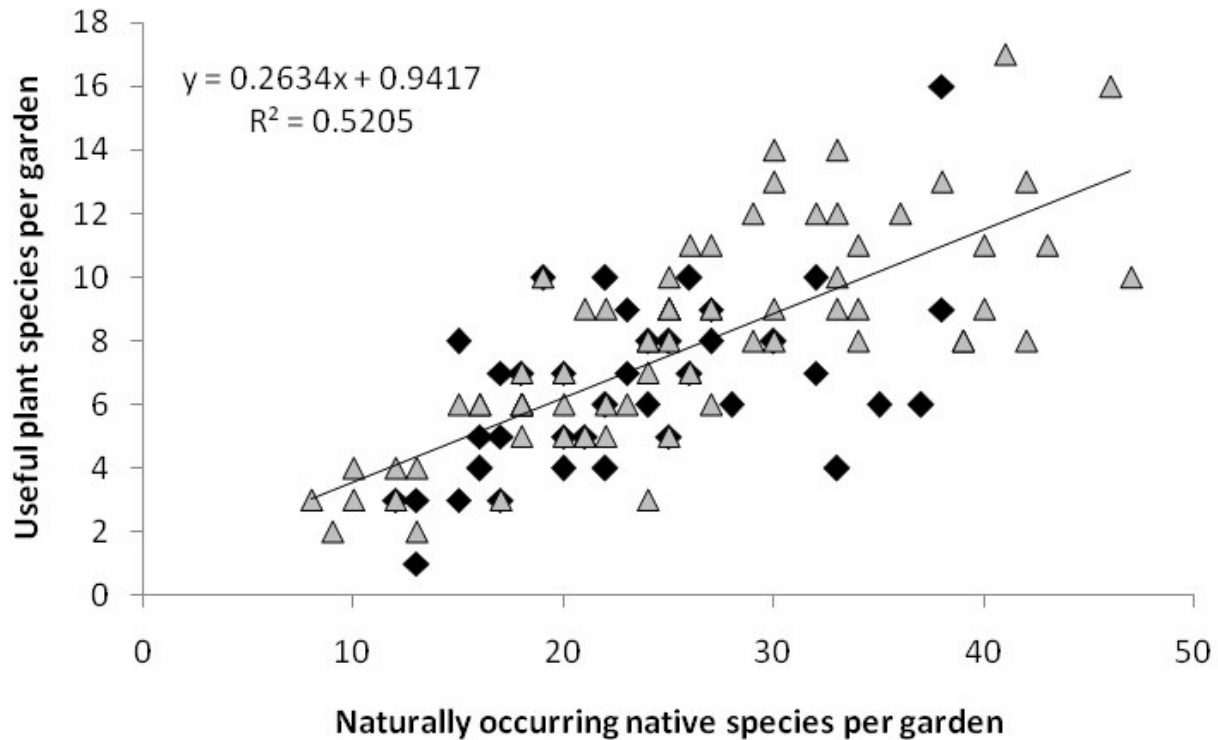


Figure 5. Linear regression of the number of naturally occurring native species and number of medicinal plant species found in rural (triangle) and peri-urban (diamond) Tswana homegardens. N=112.

did not contribute enough data to be included here. Natural areas are found in many (n=81) homegardens of deep rural and rural people areas. Gardeners reported that they harvest various medicinal species from these natural areas. A linear regression of naturally occurring indigenous species numbers with medicinal plant numbers per garden revealed that the number of medicinal species was higher in gardens with a higher richness of naturally occurring species (Figure 5). Up to 25% of medicinal plants used from the homegarden can be found as naturally occurring plants in managed patches of natural vegetation.

DISCUSSION

Indigenous versus alien

Useful plant species that are alien to South Africa account for more than 60% of species found in Tswana homegardens. This is especially the case in the homegardens of peri-urban areas. These areas have access to a larger horticultural species pool and are less bound by cultural practices and preferences (Davoren, 2009). Probably the most concerning issue, when alien species are considered, is the possibility of species becoming naturalised (Siebert et al., 2010) or invasive (Cilliers et al., 2008). Several such species have been

recorded for Tswana homegardens from rural areas (Davoren, 2009).

Deep rural and rural people manage and make better use of useful indigenous plants, suggesting that such knowledge on this topic is lost in cities (Zobolo and Mkabela, 2006). Outsiders (e.g. other cultures) have the ability to threaten tribal custodianship of indigenous species by exposing people to attractive and easily cultivated alternatives (Izidine et al., 2008). Historical aspects also influence the proportion of indigenous taxa. For instance, the high proportion of indigenous medicinal taxa probably stems from the Batswana's pastoral history (Grivetti, 1979), which allowed for useful indigenous plants to be taken directly from nature. However, due to fewer naturally occurring indigenous food plants being available in this semi-arid region, compared to the eastern and southern parts of South Africa, indigenous species were not domesticated for crop production, which could explain why the majority of the Batswana's cultivated crops are alien.

Plant use categories

Production of food crops is limited in peri-urban homegardens when compared to deep rural and rural areas. Head et al. (2004) has indicated that intensive backyard food production has lost its emphasis to a large

extent in the first generation of migrants to cities. Kirkpatrick et al. (2007) has confirmed this, showing a notable decline in the percentage of productive vegetable and fruit micro-gardens, and, similarly to the peri-urban gardens of this study, vegetables and fruit trees are cultivated amidst a substantial component of ornamentals. Generally peri-urban areas have realised the value of leafy vegetables to alleviate food insecurity (Shiundu, 2002). Especially fruit and shade trees were relatively abundant in all gardens and correspond with the findings of Paumgarten et al. (2005) for South Africa.

The occurrence of medicinal gardens in Tswana homegardens is low, but in southern Africa many species are harvested from natural areas rather than the garden (Matavele and Habib, 2000). This is, however, in contrast with homegardens of the Zulu people in South Africa, where micro-gardens with medicinal plants are the norm (Nemudzudzanyi et al., 2010). The natural areas within Tswana homegardens are also extensively harvested for indigenous medicinal species and can be considered as a type of medicinal garden, albeit unmanaged and temporary.

Ornamental plants, as a use category, were the most species rich and diverse and the abundance of species is linked to higher levels of urbanisation. The availability of aesthetic plants that are drought and cold tolerant has stimulated this European practise within the Tswana culture (Davoren, 2009), especially in peri-urban areas. Additionally, these plants are also more freely available in peri-urban areas, mostly through exposure to gardens which were kept according to European culture (Cilliers, 2010). However, ornamentals were not completely foreign to the Tswana culture, as is evident from the numerous traditional containers with succulent plants in gardens from deep rural areas (Molebatsi et al., 2010). Zulu homegardens, in contrast, are strictly cultural and functional, and ornamental species do not feature in rural areas (Nemudzudzanyi et al., 2010).

The structural use category is an indication of how residents of both rural and peri-urban areas value biodiversity, considering that plants are an important component of both the culture and livelihoods of African communities. Species cultivated for structural purposes are, as expected, more frequent in deep rural areas where the financial means do not exist to replace plant resources (High and Shackleton, 2000), that is, hedges with concrete walls, shade trees with patios, or fire screens with gas or electrified kitchens. The value of biodiversity is therefore much higher in deep rural areas where the plant diversity is conserved through their uses (Das and Das, 2005).

Garden layout

Very little work has been done on the layout of homegardens of South Africa which makes it difficult to

put our findings on garden structure in context. Two other similar studies attempted at constructing a general layout plan for home gardens in South Africa, namely Nemudzudzanyi et al. (2010) in KwaZulu-Natal and Coetzee et al. (2007) in Gauteng. The micro-gardens identified for Tswana homegardens are equivalent to what was called 'structural elements' by Coetzee et al. (2007). The Tswana gardens have micro-gardens or 'structural elements' that correspond to what were defined in the previous studies. However, the spiritual gardens of Nemudzudzanyi et al. (2010) or ancestral worship and charm elements of Coetzee et al. (2007) were not as evident in our study. Why the Tswana homegardens from this study are less spiritual and more functional requires further investigation.

Conclusion

This study revealed that Tswana homegardens are dominated by alien species, with the proportion of alien species increasing from deep rural to peri-urban areas. The hypothesis that indigenous species diversity is reduced in the peri-urban homegardens through replacement with exotic plant species is therefore supported. There are five main plant-use categories in Tswana homegardens. This study shows that in food microgardens, grains are predominant in deep rural areas and leafy vegetables in peri-urban areas. Medicinal species are rare in peri-urban areas, but ornamental species are diverse. Structural species are cultivated more often in deep rural and rural areas, especially shade trees. As the figures for deep rural and peri-urban homegardens are often dissimilar, it can therefore be said that plant use categories are influenced by urbanisation.

Six main micro-gardens were identified for Tswana homegardens. Peri-urban gardens do not support this layout fully. The number of food, medicinal, structural, open area and natural area microgardens decrease from deep rural to peri-urban homegardens. Ornamental microgardens increase in frequency from deep rural to peri-urban areas.

This study shows that Tswana homegardens constitute an Indigenous Knowledge System with a particular layout and function. Future studies could unravel the economic side of keeping useful plants and how these improve the livelihoods of poor rural communities.

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