

# FORAGE PREFERENCE OF BOER GOATS IN THE HIGHLAND SAVANNA DURING THE RAINY SEASON

## I: DIET SELECTION

A ROTHAUGE<sup>1</sup>, G KAVENDJI<sup>2</sup> and ML NGHIKEMBUA<sup>1</sup>

<sup>1</sup> Neudamm Agricultural College, Private Bag 13188, Windhoek, Namibia

<sup>2</sup> Department of Animal Science, University of Namibia, Private Bag 13301, Windhoek, Namibia

### ABSTRACT

Forage selection of free-ranging, meat-type Boer goats in open highland savanna was determined by bite counting and compared to the abundance of plants occurring in the natural vegetation, determined by step-point sampling, to establish dietary preference. Forage selection was observed over a period of six weeks in the rainy season, by following three marked does from a flock of 130 free-roaming does individually at 36 different opportunities for 30 minutes each, during their two daily periods of peak foraging activity, in the early morning and late afternoon.

Goat bites were distributed evenly across the two daily peak foraging periods. Most plants utilised (85.7%) were within easy reach of goats (<120 cm high), while they had to stretch or employ the bipedal stance in only 13.6% of bites. Goats preferred woody plants, which constituted 51.2% of their diet but only 24.5% of the natural vegetation. Grasses dominated the natural vegetation (51.9%) but formed only 29.4% of the goats' diet. Herbs and forbs contributed 18.7% to the goats' diet, roughly proportional to their occurrence in the veld (23.6%). Only 13 of the 16 woody species present in the feeding area were utilised, compared to over 40 herbaceous species taken. The most preferred forage species were the woody plants *Phaeoptilum spinosum* (13.0% of diet), *Acacia mellifera* (10.7%) and *Catophractes alexandri* (8.0%). There were no significant differences in forage preference of the three marked goats.

This trial indicates that the highland savanna of Namibia is extremely suitable for goat farming, since it offers goats a wide variety of forage species within easy foraging reach. Amongst the most preferred forage plants are woody species known to invade overgrazed savanna range, indicating the goat's potential to exploit bush-encroached areas.

### INTRODUCTION

Goats are generally considered to be browsers, at once very selective but also opportunistic feeders able to survive on degraded range where few other species of domestic livestock could maintain themselves. Studies in different parts of the world have indicated that goats in general rely on browse, i.e. forage produced by woody plants, to a greater extent than on herbaceous plants. Amongst the herbaceous plants, they prefer herbs, bulbs, weeds and other ephemeral plants to grasses (Devendra and McLeroy, 1988; Devendra, 1990). It is therefore generally recognised that goats do not compete meaningfully with grazing domestic livestock such

as sheep and cattle. Being opportunists, they can of course sustain themselves on grass if drought or other special conditions limit browse.

However, because goats utilise non-graminaceous herbaceous plants and many dwarf shrubs close to ground level, the perception exists amongst some farmers in Namibia that goats compete with grazing livestock for grass, merely because of their low head position during foraging. It is also perceived that this competition is especially intense in summer, during the rainy season, when the grasses are at their most productive and nutritious stage. This lingering fear may contribute to the reluctance of Namibia's commercial farmers, many of them farming in habitats supremely suited to goat production, to keep goats on their range. Namibia's population of domestic ruminants consists of approximately 2.2 million cattle, 2.1 million sheep and 1.7 million meat-type goats, but in stark contrast to sheep and cattle, more than 70% of goats are kept in the communal farming areas (Ministry of Agriculture, Water and Rural Development, 2000) that occupy only about 41% of the country. Other factors, such as more intense managerial requirements, abundance of predators and unconventional marketing techniques, do however, also contribute to this reluctance to engage in goat production (Bester and Reed, 1998). Roughly one-third of the national goat flock consists of Boer goats or their crosses, while the majority of goats belong to various indigenous meat-type goat breeds and strains.

Since the goat is primarily a browser, it is supremely suited to the semi-arid and arid savanna rangeland found in Namibia. Namibia is the driest country in Africa south of the Sahara and its highly seasonal climate is characterised by frequent droughts (Hutchinson, 1993). Almost 64% of the country is covered by savanna range types, most of them with a discontinuous, open to moderately dense stand of nitrogen-fixing *Acacia* trees and bushes and an apparently continuous herbaceous layer dominated by grasses. About 20% of the country is characterised by dry woodland with a fairly dense and highly diverse stand of trees and a dense undergrowth of grasses. Savannas and dry woodlands are ideally suited to extensive ruminant production, but are susceptible to bush encroachment and the degradation of the grass layer due to grazing mismanagement (Moyo et al., 1993). Possibly as much as 20 to 50% of the commercial farming area of Namibia has already suffered bush encroachment with a resultant loss of grass-based carrying capacity of 20 to 90% (Adams and Werner, 1990; Bester, 1998). Communal farming areas are also increasingly affected by range degradation and bush encroachment on millions of hectares (Behnke, 1998). These statistics indicate theoretically that, as the habitat for grazing

livestock in Namibia is deteriorating, it becomes more suitable for browsing livestock such as goats.

To counter-act popularly held beliefs, it was necessary to establish the dietary preference of goats during the rainy season, when grasses are at their best and the temptation to graze may be at a peak. There is a dearth of published information on the forage preference of meat-type goats in an *Acacia*-dominated savanna of Namibia in the rainy season, whereas their dietary preference during the vegetative dormant season, winter, has been well established recently (Rothauge and Engelbrecht, 2000), confirming goat's reliance on browse in winter. Similar information obtained in summer would elucidate to what extent goats compete with grazing livestock and whether they could be employed to utilise the woody component of bush-encroached savanna rangeland.

## **MATERIALS AND METHODS**

### **Natural vegetation:**

The trial was executed on the Neudamm Agricultural College farm, situated  $\pm$  35 km east of Windhoek. The feeding area of the goats consisted of 112 ha of typical *Acacia*-dominated highland savanna (Giess, 1971) at an altitude of approximately 1804 m above sea level. Botanical composition of the range was determined by systematic step-point sampling (Tothill, 1987) along a 2660 m long line transect, representative of the feeding area in general, using a 3 m length of steel rod to avoid diverting from the transect when encountering an obstacle such as a thorn bush. Where the falling rod struck, the plant or plant canopy hit by the rod's point was identified, or, if no plant or plant canopy was hit, the plant nearest to the strike was identified while the strike was noted to be on "bare soil". In this manner, the canopy cover of the ground was determined at the same time as the botanical composition.

These determinations were performed at the end of the 1998/99 rainy season, when plants were fully developed and could be identified easily. This rainy season delivered 279 mm of rain, only about three-quarters of the long-term average rainfall of 363 + 158.1 mm. Plants identified were grouped into four classes: woody plants (identified at species level), annual grasses, perennial grasses, and herbs and forbs. The relative abundance in the rangeland of each plant species or class was then calculated as a frequency (in %).

### **Animals:**

About 130 mature female goats of average mass (57 + 8.6 kg) of the indigenous, composite Boer goat breed roamed freely in a feeding area of 112 ha. Although this area was subdivided into four camps, the seven-string smooth wire interior fences did not restrict goat movement, but the wire-mesh perimeter fence successfully contained the animals. Does were either pregnant or in early lactation with kids at heel. Water and a molasses-based lick block were freely available at all times.

The goat flock remained in this area for the total length of the trial, eight weeks, performed at the height of the 1998/99 rainy season. A stocking intensity of 130 goats on 112 ha over only 8 weeks at the height of vegetative growth can be considered as light to moderate in the highland savanna. When stocked this lightly, goats can express their true forage preference (Mbuti et al., 1996) due to a low level of competition between foraging animals.

### **Diet selection:**

The diet selected by goats was determined by the bite-count method of Narjisse (1991), which was specially developed for these animals. It consists of following a goat closely enough (often less than 3 m) to identify the plants utilised and count the number of bites taken from each plant without interfering with the animal's foraging behaviour. Obviously, this can only be achieved after an adaptation period, during which the goat is accustomed to the close presence of an observer. After two weeks of adaptation, goats had become so used to the observer that their foraging behaviour was no longer affected.

Three individual does of average weight, in late pregnancy, were then selected at random from the goat flock and marked clearly, but not separated from the flock. Each one of these three marked does was followed for a continuous period of 30 minutes, once in the morning and again in the afternoon, on three successive days per week, over a period of six continuous weeks, for a total of 108 observation units, or 36 per doe. It had been determined during a previous trial (Rothauge and Engelbrecht, 2000) that the period from 06:00 to 10:00 in the morning and again from 15:00 to 18:00 in the afternoon constitutes the periods of peak feeding activity of goats at Neudamm.

The order in which the three marked does were observed was randomised to achieve an equal spread of does across all time intervals. Woody plants utilised were identified at species level, but herbaceous plants utilised were merely identified as annual grasses, perennial grasses, and herbs and forbs; the same classification used to describe the botanical composition of the feeding area. Provision was also made for poorly defined bites or unidentifiable plants ("unspecified bites").

In the case of woody plants, height of foraging was also determined according to the level at which the woody plant was utilised by the goat, not the absolute height of the plant. Foraging height was classified either as low (< 60 cm, roughly knee-height of the observer), medium (60-120 cm, roughly knee- to chest-height of the observer) or high (> 120 cm, taller than chest-height of the observer). The same classification was not applied to herbaceous plants since virtually all were lower than 60 cm.

Finally, all bites taken from each plant species or class were converted into a frequency (in %), representing the relative abundance of a plant in the diet of a goat. This measure is completely comparable to the relative abundance of a plant in the rangeland, calculated during botanical composition. By comparing these two measures, the dietary preference of

a goat can be established: if a plant is utilised by a goat more often than it occurs in the natural vegetation, it is obviously a preferred forage species which the goat actively seeks out to eat. Plants, which are utilised less often than they occur in the veld, are not preferred, while goats seem to display a neutral appetite towards a plant that they eat about as frequently as it is encountered in the veld. Preferred forage species should not be confused with principal forage species, which constitute a major part of an animal's diet but are not necessarily preferentially eaten (Petrides, 1975).

#### Statistical analysis:

To test whether any treatment effects were statistically significant, a t-test was performed or, if a normality test indicated skewedness of the database, a Mann-Whitney rank sum test. Differences between plant classes utilised were tested by a straightforward one-way analysis of variance, as the data was distributed normally. To establish differences between plant species within the class of woody plants, a multiple comparison procedure (Tukey's test) was performed.

The remaining differences (between the three individual does, foraging time in the morning and afternoon or foraging height) were tested statistically by either a Mann-Whitney rank sum test or a Kruskal-Wallis anova, depending on the preceding normality test (Steel and Torrie, 1980). The alpha level of significance testing was 0.05 in all instances.

## RESULTS AND DISCUSSION

The three does were observed to take a total of 10824 bites, or 3608+233.8 bites/doe. There was no significant difference ( $P = 0.95$ ) between the three does in terms of plant species or class selected (Table 1), indicating that none of the three does exhibited deviating forage preference or appetite. Pooling their individual preferences into an "all goats" column was therefore justified. There was also no statistically significant difference in the bites taken during the morning or afternoon foraging session ( $P=0.98$ ), with bites being about equally distributed (Table 2). Although it was observed that goats were reluctant to take dew-laden grass early in the morning

Table 1. Diet selection (%) of three Boer goat does in the highland savanna during the rainy season

PLANT CLASS	B I T E F R E Q U E N C Y			
	ALL GOATS	GOAT 1	GOAT 2	GOAT 3
<b>ALL WOODY PLANTS</b>	<b>51.24<sup>A</sup></b>	<b>52.65</b>	<b>48.02</b>	<b>52.94</b>
<i>Acacia hebeclada</i>	0.82 <sup>d</sup>	0.75	0.85	0.87
<i>Acacia hereroensis</i>	5.64 <sup>e</sup>	6.84	4.70	5.26
<i>Acacia karroo</i>	0.04 <sup>c</sup>	0.10	0.00	0.00
<i>Acacia mellifera</i>	10.68 <sup>a,b</sup>	11.48	10.66	9.80
<i>Catophractes alexandri</i>	8.03 <sup>a</sup>	7.92	7.21	8.98
<i>Grewia flava</i>	3.40 <sup>e</sup>	4.41	3.28	2.38
<i>Hermannia modesta</i>	0.02 <sup>c</sup>	0.00	0.06	0.00
<i>Leucosphaera bainesii</i>	0.62 <sup>d</sup>	0.49	1.17	0.20
<i>Lycium trothae</i>	0.86 <sup>d</sup>	0.36	1.37	0.90
<i>Phaeoptilum spinosum</i>	12.96 <sup>b</sup>	10.25	11.34	17.67
<i>Rhus marlothii</i>	4.18 <sup>e</sup>	5.16	3.28	3.98
<i>Tarchonanthus camphoratus</i>	2.91 <sup>d,e</sup>	3.35	3.16	2.15
<i>Ziziphus mucronata</i>	1.08 <sup>d</sup>	1.52	0.94	0.73
<b>ANNUAL GRASSES</b>	<b>10.66<sup>B</sup></b>	<b>10.92</b>	<b>10.57</b>	<b>10.47</b>
<b>PERENNIAL GRASSES</b>	<b>18.77<sup>C</sup></b>	<b>18.17</b>	<b>18.64</b>	<b>19.59</b>
<b>HERBS AND FORBS</b>	<b>18.71<sup>C</sup></b>	<b>17.55</b>	<b>22.11</b>	<b>16.54</b>
UNSPECIFIED BITES	0.62 <sup>D</sup>	0.72	0.66	0.47
<b>TOTAL</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

and preferred to delay grazing until the dew had evaporated, this did not affect the amount of grass taken proportionally in the morning or the afternoon.

Figures in the "all goats" column with different superscripts differ significantly. Capital letters (A,B,C,D) denote significant differences ( $P<0.001$ ) between plant classes, while small letters (a,b,c,d,e) denote significant differences ( $P<0.05$ ) between woody plant species only. There are no significant differences ( $P=0.95$ ) between individual goats 1, 2 and 3.

It is clear from Table 1 that goat does selected woody plants significantly more often ( $P<0.001$ ) than different classes of herbaceous plants. Woody plants made up more than half (51.24%) of all bites taken. Perennial grasses and the herbs and forbs were selected in equal measure (18.77% and 18.71% respectively, no significant difference), but significantly more often than annual grasses (10.66%). The observation error ("unspecified bites") was insignificantly small, reflecting the accuracy of the bite-count method in determining forage preference. A total of 16 woody species

Table 2. Diet selection (%) at various daily foraging times and foraging heights of goats

PLANT CLASS	DAILY FORAGING TIME MORNING : AFTERNOON	FORAGING HEIGHT LOW : MEDIUM : HIGH
<b>ALL WOODY PLANTS</b>	<b>25.67 : 25.57</b>	<b>10.12 : 63.27 : 26.61</b>
<i>Acacia hebeclada</i>	0.37 : 0.45	0.20 : 1.41 : 0.00
<i>Acacia hereroensis</i>	2.08 : 3.57	0.34 : 3.07 : 7.61
<i>Acacia karroo</i>	0.04 : 0.00	0.00 : 0.07 : 0.00
<i>Acacia mellifera</i>	5.18 : 5.50	3.66 : 11.25 : 5.93
<i>Catophractes alexandri</i>	4.48 : 3.55	0.61 : 10.64 : 4.42
<i>Grewia flava</i>	1.41 : 1.99	1.26 : 5.27 : 0.11
<i>Hermannia modesta</i>	0.02 : 0.00	0.04 : 0.00 : 0.00
<i>Leucosphaera bainesii</i>	0.45 : 0.17	1.21 : 0.00 : 0.00
<i>Lycium trothae</i>	0.35 : 0.51	0.22 : 1.46 : 0.00
<i>Phaeoptilum spinosum</i>	6.66 : 6.30	1.50 : 18.82 : 4.98
<i>Rhus marlothii</i>	2.69 : 1.49	0.05 : 5.70 : 2.40
<i>Tarchonanthus camphoratus</i>	1.30 : 1.61	0.96 : 4.45 : 0.27
<i>Ziziphus mucronata</i>	0.63 : 0.45	0.07 : 1.14 : 0.90
<b>ANNUAL GRASSES</b>	<b>5.68 : 4.98</b>	All low growing
<b>PERENNIAL GRASSES</b>	<b>9.28 : 9.50</b>	All low growing
<b>HERBS AND FORBS</b>	<b>9.48 : 9.23</b>	All low growing
<b>UNSPECIFIED BITES</b>	<b>0.39 : 0.23</b>	
<b>TOTAL</b>	<b>50.49 : 49.51</b>	<b>ca. 53.3 : 46.1</b>

occurred in the goats' feeding area, compared to more than 40 species of herbaceous plants. Goats thus selected more feed from the fewer species of woody plants than from the more diverse and abundant herbaceous plants. Although the bite-counting method does not determine the mass of vegetable matter ingested, it has been found in other parts of southern Africa that forage preference is positively correlated with forage intake (Haschick and Kerley, 1997).

When annual and perennial grasses are combined, they make up 29.43% of the diet selected and although grass now becomes the second-largest item in goat diets, it still contributes significantly less than woody plants. Comparing the intake of grass during the rainy season with that during the vegetative dormant season in winter (Rothauge and Engelbrecht, 2000), it is apparent that goats consume more grass in summer than in winter. In this limited sense, the farmers' casual observations of goats grazing more in summer than in winter, is correct, but the small amount of grass taken in both seasons (29.4% and 5.6% respectively) still does not make the goat a "grazer". It merely indicates that goats respond to changes in the palatability and nutritive value of grasses associated with a change in season, which is truly opportunistic feeding behaviour. The foraging habits of Boer goats cannot simply be extrapolated to other types of goat found in Namibia. For example, Els (2000) found that the diet of Angora goats in southern Namibia consisted of 80% of herbaceous plants and that Angora goats thus compete with sheep for grazing. Similarly, Jordaan and Le

Roux (1996) found goats to compete with cattle for the grass *Panicum maximum* in winter rather than in summer, in a dystrophic savanna of South Africa (sour bushveld). Unfortunately, very little is known about the foraging habits of indigenous meat-type goats.

The importance of browsing in the diet selected by Boer goats becomes even more obvious when the contribution of woody plants to the goat's diet is compared to the abundance of woody plants in the natural vegetation (Figure 1). Woody forage species made up only 24.46% of the natural vegetation (Table 3) but constituted 51.24% of the forage selected (Table 1), indicating that they are highly preferred. In contrast, both annual and perennial grasses seemed to be avoided by the goats, as they constituted a large part of the natural vegetation (18.71% and 33.20% respectively), but much less of the goats' diet (10.66% and 18.77% respectively). Herbs and forbs were selected in about equal measure to their occurrence in the natural vegetation (18.71% vs. 23.64%), indicating a neutral appetite towards these plants.

The feeding area of the goat flock was described botanically by a total of 973 point samples, more than enough to accurately describe the botanical composition of a rangeland (Hardy and Walker, 1991). About 59.1% of strikes were on plant canopies and 40.9% on bare ground. Both the canopy cover of the soil and the plants found in the feeding area are typical of highland savanna veld (Kellner, 1986).

Table 3. Relative abundance (%) of plants in the feeding area of goats

PLANT CLASS	RELATIVE ABUNDANCE
<b>ALL WOODY PLANTS</b>	<b>24.46*</b>
<i>Acacia hebeclada</i>	0.41
<i>Acacia hereroensis</i>	1.03
<i>Acacia karroo</i>	0.31
<i>Acacia mellifera</i>	9.04
<i>Catophractes alexandri</i>	0.82
<i>Grewia flava</i>	1.54
<i>Hermannia modesta</i>	1.13
<i>Leucosphaera bainesii</i>	1.95
<i>Lycium trothae</i>	0.62
<i>Phaeoptilum spinosum</i>	1.54
<i>Rhus marlothii</i>	0.62
<i>Tarchonanthus camphoratus</i>	3.49
<i>Ziziphus mucronata</i>	0.72
<b>ANNUAL GRASSES</b>	<b>18.71</b>
<b>PERENNIAL GRASSES</b>	<b>33.20</b>
<b>HERBS AND FORBS</b>	<b>23.64</b>
<b>UNSPECIFIED PLANTS</b>	<b>0</b>
<b>TOTAL</b>	<b>100.00</b>

\* Three unutilised woody species (unnamed) together had an abundance of 1.24 %, bringing the total for woody plants to 24.46 %.

Within the class of woody plants, differences between species utilised were statistically significant ( $P < 0.05$ , Table 1). The woody plant species most frequently selected were, in descending order, *Phaeoptilum spinosum*, *Acacia mellifera* and *Catophractes alexandri*. These three woody species alone constitute nearly one-third (31.67%) of the goats' diet during the rainy season and may be considered the principal diet components of Boer goats. However, only *P. spinosum* and *C. alexandri* were preferred forage species (Figure 1), having been utilised nearly nine times as often by goats as they occurred in the veld. It is well known locally that these two plants are also favoured by wild browsers such as the kudu (*Tragelaphus strepsiceros*). In contrast, *Acacia mellifera* was utilised in roughly the same proportion as it grew in the veld, indicating neutral behaviour towards this plant.

*A. mellifera* readily becomes invasive upon incorrect grazing management (Bester, 1998). It is encouraging to see one of the major invasive bush species in the highland savanna and Namibia at large to be well utilised by Boer goats. They appear not to have a special liking for it, but utilise it roughly to the same extent as it appears in the veld, consequently it will become an ever more important diet component where bush-thickening occurs. Although the level of utilisation of *A. mellifera* may not be severe enough to control densification (O'Connor, 1996), it is clearly an alternative method of maintaining animal production on degraded, bush-encroached savanna

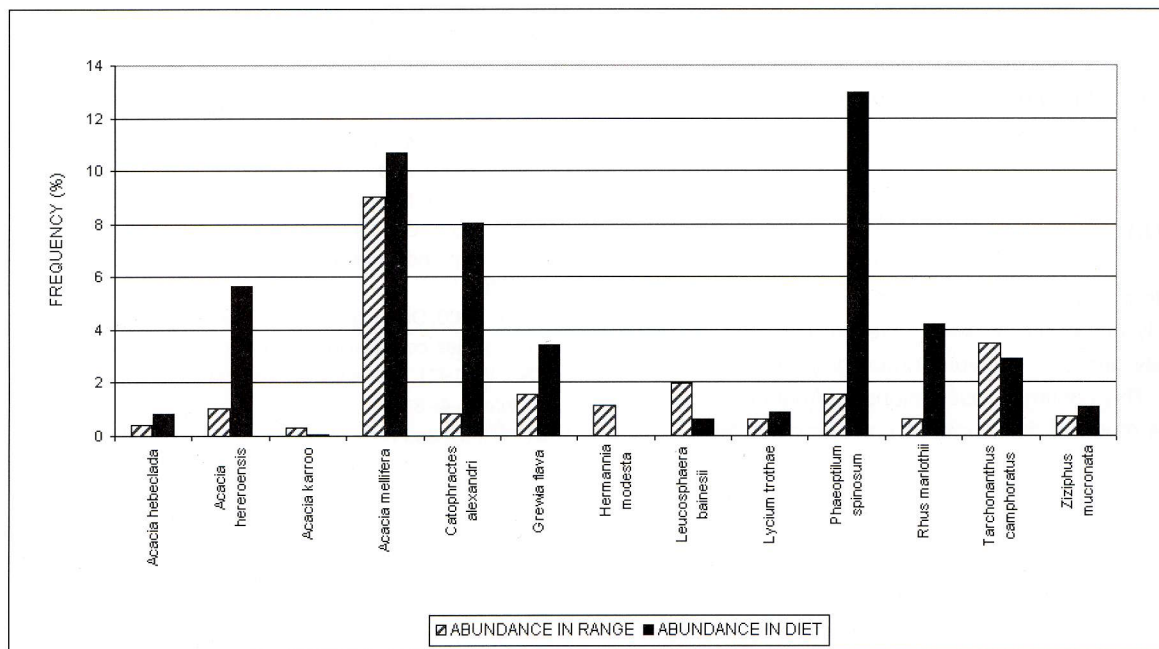


Figure 1. Preference of woody forage species by Boer goats in the highland savanna.

rangeland (Wood, 1987; Aucamp, 1990). Considering the extent of bush encroachment in Namibia, farmers can be advised to employ goats to prevent decreasing livestock biomass on their properties.

Other woody species that were utilised preferentially were *Acacia hereroensis* and *Rhus marlothii*, while *Acacia karroo*,

*Hermannia modesta* and *Leucosphaera bainesii* were avoided by goats (Figure 1). Woody species to which goats appear to be neutral include *Acacia hebeclada*, *Grewia flava*, *Lycium trothae*, *Tarchonanthus camphoratus* and *Ziziphus mucronata* (Figure 1). Most of these woody plants are thought locally to be palatable to very palatable, implying that they would be preferentially selected by goats (Coates-Palgrave,

1983; Bergström, 1998; Salinas et al., 1999). Three woody species, which did occur on the range, were not utilised at all, viz. *Acacia erioloba*, *Albizia anthelmintica* and *Eriocephalus luederitzianum*. The former two species occur as huge trees in the feeding area and their browse was physically out of reach of the goats. It is well known locally that at least the pods of *A. erioloba* are eaten well by wild and domestic ruminants, once they ripen and fall to the ground. *E. luederitzianum* must have been at an unpalatable stage of its growth cycle, or less palatable than the surrounding vegetation, because this dwarf shrub was eaten well by Boer goats in winter, contributing 10.6% to the total diet (Rothauge and Engelbrecht, 2000).

The difference in foraging height of woody plants was not significant ( $P=0.16$ , Table 2), although the data was skewed by the growth form of plants: shrubs like *Hermannia modesta* and *Leucosphaera bainesii* do not grow beyond 60 cm tall, while trees like *Acacia karroo* and *Acacia hereroensis* do not offer much forage below 120 cm. There were no significant differences between individual goats ( $P>0.59$ ). A small fraction (10.12%) of all bites from woody plants was taken near ground level (Table 2). When all "low" bites, including those from grasses, herbs and forbs, are added together, Boer goats obtained the majority of their diet (53.3%) near ground level, possibly contributing to farmers' perception that goats "graze" a lot. Another 32.4% of bites were taken at about head height (60-120 cm high), while goats had to stretch or adopt the bipedal stance in only 13.6% of bites (foraging height above 120 cm). The principal woody species (*P. spinosum*, *A. mellifera* and *C. alexandri*) were utilised most frequently at or below a goat's head height, indicating that most of the foraging material preferred by goats in the highland savanna is within easy reach.

## CONCLUSION

This trial offers conclusive evidence that Boer goats prefer to utilise woody plants, i.e. browse, even at the time of year when actively growing, nutritious green grass is available in abundance. This confirms observations by Abate (1996) who summarised much of the literature on foraging preferences of goats in arid and semi-arid Africa. It also confirms observations made locally in the dry season, when most of the grasses are dormant and the ephemerals are dead (Rothauge and Engelbrecht, 2000) and in arid rangelands of South Africa (Du Toit and Blom, 1995; Du Toit et al., 1995). It appears that goats - when given a free choice - do not compete meaningfully with grazing livestock such as sheep and cattle for grasses, even when these dominate the range, but that they prefer woody plants, irrespective of season. The lingering fear of many Namibian farmers - that goats compete with grazing livestock for grass - is therefore unjustified. In fact, browsing domestic livestock, such as Boer goats, offer alternative means of animal production on rangeland encroached by *Acacia mellifera*.

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