CHAPTER 8

Diet Preferences of Livestock

8.1 Introduction

Diet selection in terms of both quantity and quality is primarily a function of the types and amount of feed on offer. Selective grazing, due to differences in relative palatability, is a problem confronting all who are concerned with the practices of correct range utilization. Theron & Booysen (1966) identified two forms of selective grazing, namely species selective grazing and area selective grazing. The causes for differences in palatability amongst both grasses and vegetation types are as yet not clearly understood in spite of the fact that numerous attempts had been made in the past to relate preference differences to a number of factors (; Heady 1964; Theron & Booysen 1966; Gammon & Roberts 1978; O'Reagain & Mentis 1989).

The measurement of animal preferences presents numerous problems that, as yet, have not been entirely overcome. The result is that no standard method has been devised by which animal preference can be successfully measured under a variety of conditions. In this study, conducted under both controlled grazing and free–ranging conditions, research was aimed at answering pertinent questions regarding the botanical composition of diets selected by cattle, sheep and goats in different seasons and to clarify the dietary interrelationships between the animal species.

8.2 Material and methods

Freshly dropped dung or pellet samples were collected at the water point in the case of cattle, and from rectal samples in the case of sheep and goats. One or two pellets from each individual goat or sheep and a small grab sample from each mound of cattle dung were taken. At least fifteen sub - samples were collected from each animal species at a time. Sub - samples of each animal species were composited into a single sample and about 70 grams

was kept for the final sample. Samples were collected over four days within each season throughout the year. Samples were preserved immediately by adding an equal amount of coarse sodium chloride as indicated by Hansen *et al.* (1978) and air dried.

Samples of herbaceous species in the study area were collected for microhistological reference slides. Leaf samples were prepared for the slides. Sample preparation for both faecal and reference plant material were ground using a Wiley mill through a 1 mm screen. A 5 - 10 g ground sub - sample (faecal or reference plant material) was soaked in household bleach for 30 minutes to remove the pigments (Holechek *et al.* 1982). After soaking, the sub - sample was placed over a 200 mesh screen for washing with hot water for about ten minutes, making sure that all the bleach was removed. A metal templet, 2.5cm x 51cm x 1mm with a 5 - 6 mm bore opening was used to simplify the making of slide samples. A small sub - sample was filled on the bore opening when using a 75mm x 25mm slides and 40mm x 22mm cover slips. Two drops of Hertwig's clearing solution (Appendix 1) were added on the sub - sample. The slide was heated over the open flame until most of the Hertwig's solution had evaporated without burning the sample. Hover's mounting medium (Appendix 1) was then added and thoroughly mixed with the sub - sample and spread over the slide for cover slipping. A cover slip was placed over the sample and the slide was again heated until the sample mixture was bubbling evenly. The slide was pressed after being placed on a cool wet cloth until all bubbles were withdrawn from under the cover slip. Slides were dried at 50 - 55 ^{0}C.

Five slides per faecal sample were prepared for each animal species (cattle, sheep and goats) and two slides for each plant species for the reference plant material.

A microscope using 100X objective was used to identify plant species or genera based on the epidermal characteristics. At each location (field) in the slide, plant species present were recorded. Twenty fields were read from each of the five faecal slides, resulting into a total of 100 fields per sample. The characteristics in the sample slides were matched with those in the reference material. The percentage frequency of each identified plant species was converted to density of particles per microscope field (Dearden *et al.*1975; Sparks &

Malechek 1968). The relative density of fragments was then obtained from the frequency figures.

Example:

Frequency of five slides from sheep faecal sample

5 slides x 20 fields/slide = 100 microscopic fields examined

Digitaria eriantha occurred in 33 of the fields

% frequency = 33 / 100 occupancies X 100 = 33%

Density of fragments per microscopic field

Density = In [1 - (F/100)]

where In = natural logarithm and F = frequency (%)

$$\text{Relative Density} = \frac{\text{Density of fragments per species}}{\text{Sum of densities of fragments of all species}} \times 100$$

8.3 Statistical analysis

Plant species diversity was calculated to indicate the diet breadth, on the basis of Shannon-Wiener Function (Krebs 1989) formula:

$$H' = \sum^{n}_{1=1} (p_i)(\log_e P_i)$$

Where p_i = the proportion (%) of total sample belonging to the i^{th} species in the diet

and n = total number of resource states

Plant species diversity indices indicates variety and evenness of components in the diet. The index increases with an increasing number of plants in the diet. High species diversity indices indicate that the animals do not rely on a few plant species for most of their diet, but feed on a broad spectrum. Animal species characterized by high species diversities are potentially better able to adapt their diet changes in plant composition. H' was selected because it is independent of sample size. Wolda (1981), however, indicated that it was sensitive to changes of rare species in the community.

Food habit studies of more than one animal species usually compare diet overlaps between any combination of two diets. Dung analyses for botanical composition can be used to estimate the appropriate amount of diet overlap between different animal species. Overlap between diets was calculated using Morisita's similarity index (Morisita 1959)

$C = 2 \sum n_{ij}\, n) / [(\lambda_1 + \lambda_2) N_j N_k]$

Where C_λ = Morisita's index of diversity of similarity between samples j and k (e. g. between cattle and sheep)

$N_{ij}\, n_{ik}$ = no. of individual of species i in sample j and sample k

$N_k = \sum n_{ik}$ = total no. of species in sample k (e.g. cattle)

$\lambda_1 = \sum^n [n_{ij\,(ij}\, (n_{ij} - 1) / N_j (N_j - 1)]$

A similarity index represents the percentage of the diet that is identical, or the percentage of the diet that is shared by two animals. This index was preferred over other similarity indices because it is independent of sample size and species diversity (Wolda 1981) and it shows potential for forage competition between animals.

Relative preference indices (RPI) for different plant species by different animals were determined using Krueger's (1972) formula:

RPI = % frequency in the diet composition / % frequency on the range composition

Following calculations, the main effects of seasons and animals were determined using GLM procedure SAS (1985). Where significant differences occurred, Scheffe's test was used to separate the means.

8.4 RESULTS

8.4.1 Livestock Diet Compositions under free ranging conditions

The list of plant species identified in the dung samples of cattle, sheep and goats grazing under both controlled and free ranging conditions is presented in Table 8.1. Thirty six plant species comprised the diet of these animal species. Three grasses, two forbs and one woody plant could not be identified from the dung samples. Of the eighteen grass species found in the dung samples, 78%, 68%, and 55% were found in the dung of cattle, sheep and goats, respectively. Forbs were insignificant in the diets of these animals.

Table 8.1 List of plant species occurring in seasonal diets of cattle, sheep and goats for both controlled grazing conditions and free – range grazing

Grasses	**Forbs**	**Woody plants**
A. congesta	C. beiscensis	A. fleckii
A.graciliflora	I. daleoides	A. gerrardii
D. aegyptiun	Sida cordifolia	B. albitrunca
D. eriantha	T. terrestris	B. petersiana
E. lehmanniana	FOR1	C. gratissimus
E. pallens	FOR2	D. cinerea
E. rigidior		G. flava
E. africana		G. retinervis
M. albescens		M. sericea
M. repens		R. bravispinosum
P. maximum		T. sericea
P. squarrosa		WD1
S. pappophoroides		
S. uniplumis		
U. trichopus		
GRA1		
GRA2		
GRA3		

8.4.2 Diet composition of cattle

Seasonal diet compositions of cattle, sheep and goats are illustrated in Fig. 8.1. A total of 25 plant species were found in the diet of cattle of which included 75% grasses, 23% browse and 2% forbs. Seasonally, cattle diets were dominated by grass species. Nine grass species with >1% density, occurred in the diet of cattle throughout the year and eight browse species were observed in the dung samples during the wet and dry seasons (Table 8.2). Dichrostachys cinerea was observed only during the summer period. The occurrence of forbs in the dung was insignificant. That epidermal tissues of forbs were not easily found in cattle and sheep faeces (Free *et al.* 1970; McInnis 1977) or in that of grey rhebuck (Ferreira & Bigalke 1987). The dominant grasses occurring in the diet of cattle included D. eriantha, U. trichopus, S pappophoroides, E. lehmanniana, M albescens, E. rigidior and S. uniplumis while woody species included G. flava. M. sericea, C. gratissmus, B. petersiana, B. albitrunca and A. gerrardii.

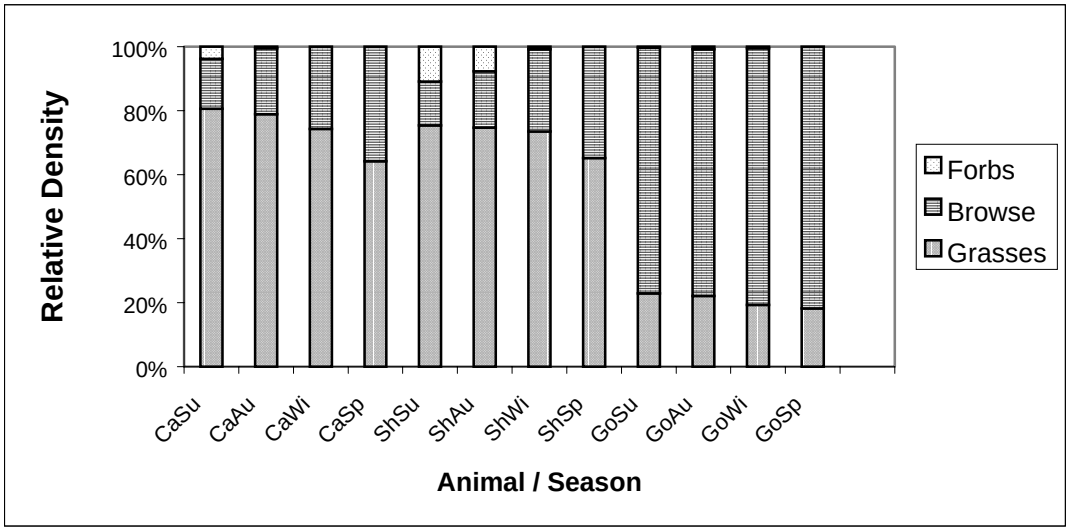

Fig 8.1 Average seasonal plant species class distribution between diets of cattle, sheep and goats in free ranging conditions.

Key to animal / season: Ca = cattle, Sh = sheep,

Go = goats, Su = summer, Au = autumn, Wi = winter and Sp = spring.

Table 8.2 Average relative densities (%; mean ± SE) of plant species in seasonal diets of cattle in free ranging conditions

Plant species	Summer	Autumn	Winter	Spring	Mean
A. congesta	0.3 ± 0.2	0.2 ± 0.1	0	0.1 ± 0.1	0.15
A. graciliflora	0.3 ± 0.1	0.1 ± 0.1	0.3 + 0.1	0.4 ± 0.2	0.28
D. aegyptium	0.3 ± 0.3	0.4 ± 0.1	0	0	0.18
D. eriantha	9.9 + 1.2	15.1 + 0.6	14.4 + 1.2	10.7 + 0.6	12.53
E. lehmanniana	9.3 ± 0.4	10.2 ± 1.2	9.9 + 0.7	8.7 ± 0.7	9.53
E. pallens	0.8 ± 0.1	0.3 ± 0.1	0.2 + 0.1	0.2 ± 0.1	0.38
E. rigidior	7.4 ± 1.1	8.3 ± 0.8	9.4 + 0.5	13.8 ± 1.2	9.73
E. africana	1.9 ± 0.1	0.7 ± 0.1	0	0	0.56
M. albescens	12.7 ± 1.3	11.0 ±1.1	8.7 ± 0.9	3.9 ± 0.9	9.1
P. squarrosa	0.4 ± 0.1	0	0	0	0.10
M. repens	0.9 ± 0.1	0.4 ± 0.1	0	0	0.31
S. uniplumis	7.8 ± 0.5	9.3 ± 1.4	10..8 ± 0.6	13.3 ± 1.8	10.3
S.pappophoroides	10.4 ± 1.3	12.2 ± 1.6	11.7 ± 0.9	9.8 ± 0.9	11.0
U. trichopus	13.9 ± 1.2	10.7 ± 0.9	6.3 ± 0.7	3.6 ± 0.7	8.6
C. beiscensis	1.3 + 0.1	0.5 ± 0.1	0	0	0.45
S. cordifolia	0.2 ± 0.1	0	0	0	0.05
T. terrestris	2.3 ± 0.2	05 ± 0.2	0	0	0.7
B. albitrunca	2.6 ± 0.4	3.1 ± 0.2	4.3 ± 0.4	6.1 ± 0.2	4.0
B. petersiana	2.9 ± 0.1	2.3 ± 0.3	2.9 ± 0.3	3.5 ± 0.1	2.90
C. gratissimus	3.4 ± 0.4	4.7 ± 1.2	5.9 ± 0.8	7.6 ± 0.5	5.40
D. cinerea	0.4 ± 0.1	0	0	0	0.10
G. flava	4.4 ± 0.3	4.9 ± 0.6	6.2 ± 0.7	8.7 ± 0.8	6.10
G. retinervis	0.4 ± 0.1	2.1 ± 0.1	2.0 ± 0.3	2.3 ± 0.2	1.70
M. sericea	3.4 ± 0.2	3.9 ± 1.3	6.7 ± 0.9	6.5 ± 1.2	5.13
T. sericea	0.1 ± 0.1	0	0.1 ± 0.1	0.8 ± 0.1	0.25

8.4.3 Diet Composition of sheep

Diet of sheep consisted of twenty one plant species; of which 74% were grasses, 21% woody species and 5% forbs (Fig. 8.1). The dominant grass species included D. eriantha, S. pappophoroides, M. albescens, U.trichopus, E. lehmaniana and major woody species included G. flava, M. sericea, C. gratissimus (Table 8.3). Higher amount of grass and forbs were found in the diet of sheep during the summer period than in spring. The relative densities of browse in sheep diets were lower during wet seasons and higher during dry seasons.

Table 8. 3 Average relative densities (%; mean ± SE) of plant species in seasonal diet of sheep in free ranging conditions

Plant species	Summer	Autumn	Winter	Spring	Mean
A. graciliflora	0.3 ± 0.1	0.2 ± 0.2	0.2 + 0.1	0.3 + 0.1	0.25
D. aegyptium	3.7 ± 0.5	2.8 ± 0.2	1.3 ± 0.3	0	3.90
D. eriantha	13.1 ± 1.0	13.8 ± 0.6	11.9 ± 0.8	10.6 ± 0.6	12.35
E. lehmanniana	10.3 ± 0.5	9.8 ± 0.8	9.2 ± 0.5	8.4 ± 0.6	9.45
E. rigidior	6.7 ± 1.3	8.4 ± 0.5	8.4 ± 0.6	9.3 ± 0.7	8.20
Eragrostis spp.	0.9 ± 0.1	0.8 ± 0.1	0	0	0.43
M. albescens	13.0 ± 0.7	11.2 ± 0.4	12.7 ± 0.6	6.9 ± 1.3	10.95
M. repens	1.4 ± 0.9	0.8 ± 0.2	0	0	0.55
S. uniplumis	1.0 + 0.1	2.7 ± 0.3	3.5 ± 0.5	4.4 ± 0.6	2.90
U. trichopus	16.3 ± 1.2	13.4 ± 1.1	12.5 ± 0.7	7.8 ± 0.9	12.50
S. pappophoroides	9.5 ± 0.8	11.1 ± 0.8	13.9 ± 1.2	17.6 ± 1.5	13.10
C. beinscensis	6.3 ± 0.5	4.3 ± 0.7	0.8 ± 0.1	0	2.85
T. terrestris	4.7 ± 1.4	3.4 ± 0.8	0	0	2.0
Forb 3	0.2 + 0.1	0	0	0	0.05
A. fleckii	0.2 ± 0.1	0.4 ± 0.1	0	0.5 ± 0.1	0.28
A. gerrardii	0	0.8 ± 0.3	1.4 ± 0.8	3.4 ± 0.2	1.40
B. albitrunca	1.5 ± 4.4	1.8 ± 0.4	2.8 ± 0.4	4.5 ± 0.4	2.65
B. petersiana	1.4 ± 0.6	2.2 ± 0.2	2.8 ± 0.6	2.8 ± 0.5	2.33
C. gratissimus	2.9 ± 0.3	3.6 ± 0.6	5.3 ± 0.4	7.6 ± 0.6	4.60
D. cinerea	1.2 ± 0.2	1.6 ± 0.4	2.1 ± 0.1	2.8 ± 0.2	1.93
G. flava	3.3 ± 0.7	4.0 ± 0.5	5.8 ± 0.7	8.1 ± 0.5	5.30
M. sericea	2.8 ± 0.2	3.2 ± 0.6	4.7 ± 0.8	5.3 ± 0.3	4.0
R. bravisponosum	0.5 ± 0.1	0	0.7 ± 0.1	0	0.30

8.4.4 Diet Composition of goats

The diet of goat was composed of 78% woody species, 20% grasses and 2% forbs (Fig. 8.1). Seasonally, the goat diet composition contained over 72% browse. In summer, the diet was 72% browse and this increased to 82% in spring. Species of woody plants occurring in goat diets included G. flava, G. retinervis, M. sericea, C. gratissmus, D. cinerea, B. petersiana, B. albitrunca, A. gerrardii (Table 8.4). The dominant grasses in their diet included D. eriantha, E. lehmanniana, S. pappophoroides, U. trichopus and M. albescens. Seasonally, the goats were found to concentrate on woody species. Plant species composition of their diet tended to vary little throughout the year.

Table 8.4 Average relative densities (%; mean ± SE) of plant species in seasonal diet of goats in free range grazing conditions

Plant species	Summer	Autumn	Winter	Spring	Mean
A. congesta	0.3 ± 0.1	0.2 ± 0.1	0	0	0.13
D. aegyptium	0.3 +0.2	0.3 + 0.2	0	0	0.15
D. eriantha	4.5 ± 0.2	4.4 ± 0.2	3.4 ± 0.1	3.3 ± 0.1	3.90
E. lehmanniana	3.5 ± 0.4	3.2 ± 0.3	2.7 ± 0.3	2.3 ± 0.3	2.93
E. pallens	0.5 ± 0.3	0.7 ± 0.2	0.3 ± 0.1	0.4 ± 0.2	0.48
E. rigidior	1.2 ± 0.2	1.3 ± 0.1	1.5 ± 0.1	1.5 ± 0.1	1.38
M. albescens	3.4 ± 0.2	3.5 ± 0.1	2.8 ± 0.2	2.9 ± 0.1	3.15
S. uniplumis	0.7 ± 0.1	0.9 ± 0.2	0.6 ± 0.1	0.9 ± 0.1	0.78
U. trichopus	3.4 ± 0.4	3.6 ± 0.3	3.8 ± 0.2	3.5 ± 0.3	3.58
S. pappophoroides	4.1 ± 0.5	4.0 ± 0.4	4.0 ± 0.2	3.8 ± 0.4	3.98
GRA 1	0.2 + 0.1	0.3 + 0.1	0	0	0.13
I. daleoides	0.4 + 0.2	0.3 + 0.1	0	0	0.18
S. cordifolia	0.3 ± 0.1	0.8 ± 0.1	0.5 ± 0.1	0	0.40
T. terrestris	0.6 + 0.3	0.3 + 0.1	0	0	0.23
A. fleckii	0.5 +0.1	1.5 + 0.1	0.8 + 0.1	0	0.70
A. gerrardii	4.1 ± 0.2	3.9 ± 0.3	4.3 ± 0.5	3.8 ± 0.3	4.0
B. albitrunca	6.6 ± 0.4	7.1 ± 0.2	8.4 ± 0.8	7.8 ± 0.4	7.48
B. petersiana	11.3 ± 0.9	11.7 ± 0.3	9.7 ± 0.3	8.4 ± 0.4	10.28
C. gratissimus	10.9 ± 1.2	12.7 ± 0.9	13.5 ± 0.6	15.9 ± 0.6	13.25
D. cinerea	13.4 ± 0.4	13.5 ± 0.9	12.9 ± 0.5	11.9 ± 0.7	12.93
G. flava	12.2 ± 0.6	13.6 ± 1.4	14.3 ± 0.3	16.6 ± 1.1	14.18
G. retinervis	2.1 ± 0.4	2.2 ± 0.2	3.1 ± 0.3	3.4 ± 0.2	2.70
M. sericea	9.6 ± 0.3	12.2 ± 0.7	13.6 ± 0.4	14.9 ± 0.7	12.58
R. bravispinosum	0.6 ± 0.1	0.7 ± 0.1	0	0	0.33
T. sericea	0.2 + 0.1	0	0	0	0.05
WD1	0.4 ± 0.2	0.6 ± 0.2	0	1.0 ± 0.6	0.5

8.5 Plant species diversity in cattle, sheep and goat diets

The annual mean of plant diversity for cattle, sheep and goats was 21.1 (Table 8.5). Seasonal species diversity was significantly ($P<0.05$) higher in summer and lowest in spring. Average plant species diversity for cattle, sheep and goats was 19.4, 21.4, and 22.5, respectively.

Table 8. 5. Average plant species diversities (%) of seasonal diets of cattle, sheep and goats in free ranging conditions

	Livestock Type			
Season	**Cattle**	**Sheep**	**Goats**	**Mean**
Summer	22.4[a]	21.8[a]	24.5[a]	22.9[a]
Autumn	20.9[b]	21.5[a]	22.7[b]	21.7a
Winter	19.2[b]	21.2[ab]	22.9[b]	21.1[b]
Spring	17.1[c]	18.7[b]	19.9[c]	18.6[c]
Mean	19.9	20.8	22.5	21.1

Means within each animal species followed by the same letter are not significantly different (>0.05)

Diets of goats were highest in average species diversity and cattle were lowest. Plant species diversity in cattle, sheep and goats diet were higher during the plant growing seasons (summer and autumn) and lower during dormant seasons (winter and spring). Probably the high quality and greater availability of forage during growing periods permitted animals to concentrate their diets selection on a wider range of plant species with little or no risk of nutritional stress. Animal foraging habits changed as the dormant seasons approached and shifted their diets to include woody plants during dormant seasons because of the decline in herbaceous quality and loss of most of the ephemeral annual species.

In general, low plant diversity indicates the inability of an animal to withstand periods of scarce forage as the ability to shift from one resource to another become a crucial adaptational tool. This means that goats can withstand harsh conditions better than cattle or sheep

8.6 Diet overlaps of cattle, sheep and goats in free ranging conditions

Diet overlaps of any combination of two livestock species differed significantly ($P<0.05$) by season (Table 8.6). The overlaps ranged from high for combinations involving animals that share similar forage types (eg. cattle and sheep) to low for combinations involving different foraging habits (eg. cattle and goats). The overlap of diets was greatest during the dry periods (winter and spring) and lowest in during wet periods (summer and autumn) for each animal combination. The observed overlaps reflect seasonal influences as animals shift diet focus.

Table 8.6 Seasonal diet overlaps (%) of cattle, sheep and goats in free range grazing conditions

	SEASONS				
Animal	**Summer**	**Autumn**	**Winter**	**Spring**	**Mean**
Cattle vs sheep	47^{b}	44.7^{b}	59.3^{a}	57.8^{a}	52.2
Cattle vs goats	14.3^{b}	16.3^{b}	15.0^{b}	21.0^{a}	16.65
Sheep vs goats	38.1^{a}	35.0^{a}	37.0^{a}	41.2^{b}	37.5
Mean	33.0	32.0	37.1	40.0	

Means within each season followed by the same letter are not significantly ($P>0.05$) different

Overlaps of diets during the growing seasons are less likely to result in serious competition for forage between animals, than overlaps occurring during dormant seasons, because forage phytomass is abundant during the growing seasons. However, during years of subnormal forage production/availability, competition between animals may also be high during the growing seasons.

8.7 Relative Preference Indices of cattle, sheep and goats

Fifteen of the most frequently occurring herbaceous species in the diets of cattle, sheep and goats were compared with their respective frequencies of occurrence on the rangeland to determine the individual species preference by the study animals (Table 8.7). Cattle preferred (RPI >2) five of the fifteen herbaceous species in the following order: D. eriantha, S. pappophoroides, U. trichopus, M albescens and E. lehmanniana. The relative preference order of sheep was S. pappophoroides, D. eriantha, U. trichopus and E. lehmanniana. Goats showed a weak preference (RPI 1 - <2) with the following order S. pappophoroides, D. eriantha, U. trichopus and E. lehmanniana. Therefore, the relative preference for cattle (grazer), sheep (mixed feeder) and goat (browser), showed the greatest potential competition for only four grasses (D. eriantha, E. lehmanniana, S. pappophoroides and U. trichopus). However, the relative preference indices of grasses found in goat diets tended to be low. The competition for the latter grasses tended to be high for cattle and sheep.

Table 8.7 Relative preference indices (RPI) of herbaceous plant species occurring in cattle, sheep and goats diets for vegetation in free – range grazing

Herbaceous spp.	**Cattle**	**Sheep**	**Goats**
A. congesta	0.1	0	0
A. graciliflora	0.3[d]	0	0
D. eagyptium	0.35[d]	0.21[d]	0
D. eriantha	5.58[a]	3.74[b]	1.23[a]
E. lehmanniana	2.11[c]	2.21[bc]	1.02[a]
E. rigidior	1.7$_{cd}$	1.51[c]	0.91[b]
M. albescens	2.6[bc]	1.75[c]	0.53[c]
P. squarrosa	0.01[d]	0	0
M. repens	0.03[d]	0	0
S. uniplumis	1.89[cd]	0.94[d]	0.50c
S. pappophoroides	4.02[b]	4.52[a]	1.38[a]
U. trichopus	3.4[b]	2.26b[c]	1.2[a]
C. beiscensis	0.01[d]	0.53[d]	0
S. cordifolia	0	0	0.12[c]
T. terrestris	0.13[d]	0.10[d]	0
Mean	**1.48**	**1.18**	**0.45**

Means within each animal followed by the same letter are not significantly (P>0.05) different

Eleven woody species were selected for comparison with their respective frequency on the rangeland to determine ranks in the diets (Table 8.8). Competition for browse plant species tended to be less for cattle, sheep and goats compared to the grass component. In general, cattle and sheep tend to have a weak mean preference for browse. However, certain plants species had higher relative preference indices. Cattle and sheep preferred five browse species (C. gratissimus, G. flava, M. sericea, B. albitrunca and B. petersiana).

Table 8.8 Relative preference indices (RPI) of browse species occurring in cattle, sheep and goats diets for vegetation in free range grazing conditions

Browse spp	Cattle	Sheep	Goats
A. fleckii	0	0.02^{d}	1.20^{e}
A. gerrardii	0.01^{d}	0.02^{d}	4.20^{c}
B. albitrunca	2.87^{a}	2.90^{a}	6.71^{b}
B. petersiana	0.91^{a}	1.21^{c}	3.01^{d}
C. gratissimus	2.27^{ab}	2.25^{b}	8.68^{a}
D. cinerea	0.01^{d}	0.05^{d}	4.71^{c}
G. flava	2.93^{a}	3.04^{a}	6.90^{b}
G. retinervis	0.05^{d}	0	1.05^{e}
M. sericea	1.92^{b}	1.40^{c}	3.57^{cd}
R. bravispinosum	0	0.03^{d}	0.91^{e}
T. sericea	0.01^{d}	0	0
Mean	**0.99**	**0.99**	**3.73**

Means within each animal followed by the same letter are not significantly (P>0. 05) different.

Goats preferred seven of the browse species but browsed all but one of the ten species (Table 8.8). The mean relative preference index for browse by goats was more than three times that of cattle and sheep. The greatest relative preference index for any species (likely to compete for) was that by cattle, sheep and goats for G. flava and C. gratissimus and B. albitrunca.

Cattle did not prefer plant species in order of availability, for instance, the six most highly ranked grasses in their diet were not the most available (gm^{2}) on the rangeland. For example, S. pappophoroides, one of the most highly preferred in the diet of cattle, was not only among the least common on the rangeland, but also the least available in terms of phytomass. On the other hand, S. uniplumis, one of the less preferred species was one of the most frequently occurring and most available (gm^{-2}) of all the herbaceous species throughout the year (chapter 5).

8.8 Diet composition of cattle under controlled grazing conditions at Makhi ranch

The plant species observed in the dung of steers under controlled grazing conditions at Makhi ranch is presented in Table 8.1. Cattle diet consisted of 74%, 23% and 2% of grasses, browse plants and forbs, respectively Fig. 8.2).

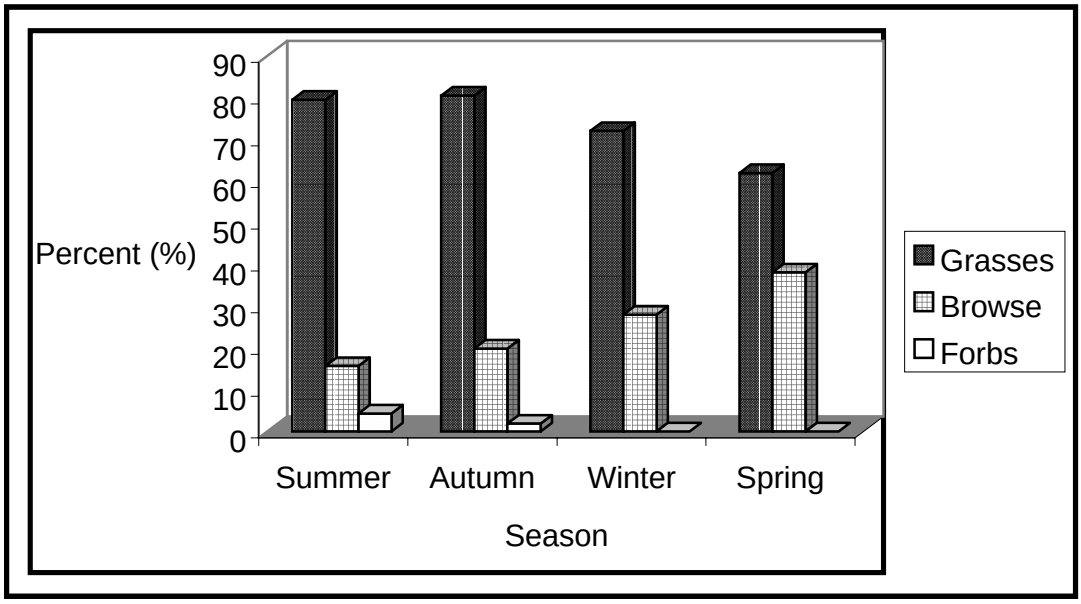

Fig. 8.2 Seasonal plant class distribution occurring in cattle diets under controlled grazing conditions

Cattle diets consisted of 80% grass during the wet seasons. This declined to approxmately 60% in spring. Browse in the diet of cattle was 16%, 20%, 28% and 38% in summer, autumn, winter and spring, respectively. Seasonal steer diets were dominated by grasses. Fifteen grasses, with a relative density >1%, occurred in the diet throughout the year (Table 8.9). Seven browse species were found during summer and autumn seasons and six during the winter and spring. Insignificant numbers of forbs occurred in the diet during the growing seasons and no observations were recorded during the dry season. Dominant grasses were the same as those at Masaane or Motshwagole cattle posts.

Table. 8.9 Average relative densities (%; mean $\pm$ SE) of plant species occurring in seasonal diet of cattle under controlled grazing conditions.

Plant species	**Summer**	**Autumn**	**Winter**	**Spring**	**Mean**
A. graciliflora	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1	0.28
D. aegyptium	0.9 ± 0.2	0.6 ± 0.2	0	0	0.38
D. eriantha	11.1 ± 0.9	14.9 ± 0.1.1	15.4 ± 0.9	17.8 ± 1.2	14.80
E. lehmanniana	10.3 ± 1.2	9.2 ± 0.6	8.3 ± 0.8	7.5 ± 0.6	8.82
E. rigidior	6.7 ± 0.6	8.4 ± 0.7	8.3 ± 0.9	8.8 ± 1.3	8.12
M. albescens	13.3 ± 1.3	11.5 ± 0.8	9.4 ± 0.6	4.5 ± 0.7	9.68
M. repens	0.5 ± 0.2	0.2 ± 0.1	0	0	0.18
P. maximum	0.8 ± 0.2	1.3 ± 0.2	0.8 ± 0.3	0	0.73
P. squarrosa	0.3 ± 0.1	0.2 ± 0.1	0	0	0.13
S. pappophoroides	13.2 ± 1.4	13..2 ± 1.2	11.2 ± 1.7	9.1 ± 0.6	11.68
S. uniplumis	6.3 ± 0.5	8.7 ± 1.3	10.7 ± 1.1	8.4 ± 0.9	8.53
U. trichopus	15.6 ± 1.4	12.3 ± 0.9	7.6 ±0.4	4.8 ± 0.6	10.08
GRA1	0.3 ± 0.1	0	0	0	0.08
C. beiscensis	1.2 ± 0.3	0.6 ± 0.2	0	0	0.45
I. daleoides	0.6 ± 0.2	0.4 ± 0.1	0	0	0.25
T. terrestris	2.1 ± 0.2	0.9 ± 0.2	0	0	0.75
FOR2	0.4 ± 0.1	0	0	0	0.1
B. albitrunca	2.1 ± 0.3	2.9 ± 0.3	4.2 ± 0.8	6.9 ± 0.5	4.03
B. petersiana	2.5 ± 0.6	2.6 ± 0.6	2.9 ± 0.3	3.8 ± 0.7	2.95
C. gratissimus	3.5 ± 0.5	4.7 ± 0.6	6.2 ± 0.4	8.4 ± 0.9	5.70
D. cinerea	0.6 ± 0.1	0.2 ± 0.1	0	0	0.20
G. flava	3.8 ± 0.8	4.4 ± 1.2	7.3 ± 1.0	9.9 ± 0.5	6.35
G. retinervis	0.7 ± 0.1	1.2 ± 0.7	2.1 ± 0.6	2.0 ± 0.6	1.50
M. sericea	2.8 ± 0.6	3.9 ± 1.4	5.6 ± 1.5	7.1 ± 0.6	4.85

8.9 Seasonal species diversity of steer diets under controlled grazing conditions

The mean annual species diversity for cattle grazing under controlled grazing conditions was 18.9 (Table 8.10). The seasonal species diversities were highest in summer and lowest in spring seasons. As under free ranging conditions, cattle diet diversities were high during growing periods and low during the dormant periods.

Table 8.10 Seasonal species diversity of steer diet for three grazing systems at Makhi ranch

	Grazing systems			
Season	**1 – pd**	**3 – pd**	**9 – pd**	**Mean**
Summer	22.9[a]	22.4[a]	23.5[a]	22.9[a]
Autumn	21.8[a]	22.0[a]	22.8[a]	22.2[a]
Winter	14.6[b]	15.1[b]	18.2[b]	16.0[b]
Spring	13.1[b]	13.4[b]	16.7[b]	14.4[b]
Mean	18.1	18.2	20.4	18.9

Means within each grazing system followed by the same letter are not significantly (P>0.05) different

Steers might have responded to the seasonal fluctuations in forage quality by consuming a greater variety of plant species during the wet seasons because of increased forage quality. Seasonal diet for steers was more diverse with the 9 – pd grazing system and less with 1 – pd system. Steers in 1 – pd system concentrated on fewer species (probably high quality) that could satisfy their stomach fill, while the 9 – pd system could not supply enough quality species to satisfy their needs and were forced to utilize other species because of the small size of the paddocks and reduced opportunity for selection. The 3 – pd system tended to be very similar to the 1 – pd system.

8.10 Relative preference indices of steers under controlled grazing conditions at Makhi ranch

The most frequently occurring herbaceous species in the diet of steers at Makhi ranch were compared with their respective occurrence on the rangeland (i.e.% frequency in diet / % frequency on range) to determine the individual species preference by steers (Table 8.11). Steers preferred (RPI >2) seven of the fifteen herbaceous species in the following order of preference: D. eriantha, P. maximum, D. aegyptium, E. africana, S. pappophoroides, U.trichopus and E. lehmanniana. It should be noted that D. aegyptium and E. africana were only found where animals concentrate their dung and urine, while P. maximum was confined to under tree canopies where high organic matter resulted from leaf drop.

Table 8.11 Relative preference indices (RPI) of plant species occurring in steer diets under controlled grazing conditions

Grass species	**RPI**	**Woody species**	**RPI**
A. congesta	0.1^{d}	B. albitrunca	2.91^{ab}
A. graciliflora	0.2^{d}	B. petersiana	1.27^{c}
D. aegyptium	5.1^{a}	C. gratissimus	2.39^{b}
D. eriantha	5.5^{a}	D. cinerea	0.01^{d}
E. lehmanniana	2.1^{b}	G. flava	3.3^{a}
E. pallens	0.1^{d}	G. retinervis	0.5^{d}
E. rigidior	1.9^{c}	M. sericea	1.9^{c}
E. africana	4.6^{a}	WDY1	0.01^{d}
M. albescens	2.5^{b}		
M. repens	0.1^{d}	**Forb species**	
P. maximum	5.8^{a}	C. beiscensis	3.7^{a}
P. squarrosa	0.1^{d}	I. daleoides	0.
S. pappophoroides	4.5^{a}	T. terrestris	2.7^{b}
S. uniplumis	1.9^{c}	FOR1	0.1^{d}
U. tricopus	3.2^{b}		
GRA1	0.1^{d}		
GRA2	0.1^{d}		

In general cattle tended to have a weak preference for browse compared to herbaceous plants. The most preferred (RPI >2) were utilized in the following order: G. flava, B. albitrunca and C. gratissimus. Cassia beiscensis and T. terrestris (forbs) were preferred by cattle than any of forbs.

Cattle did not prefer species in order of availability, for instance, the most highly ranked

grasses in their diet were not the most frequently occurring on the rangeland. P. maximum, although one of the most highly preferred in the diet of cattle, was among the least available in terms of phytomass. On the other hand, S.uniplumis and E. rigidior, some of the less preferred species, were some of the most frequently occurring and most available (gm^{-2}) of all the species throughout the year (chapter 5).

8.11 DISCUSSION

The microhistological technique is a useful tool for estimating the botanical composition of livestock diets. As reported by Storr (1961), Free *et al*. (1970) and McInnis (1977), the technique under-estimates the forbs in the diet of livestock. Plant characteristics of the fragments were also more easily identified for woody plants than grasses.

Seasonally, cattle diets were dominated by grasses. This emphasized the feeding habit of cattle as mainly grass feeders. The woody species occurring in their diet during the dry periods are in agreement with the findings of various workers. Le Houérou (1980) found woody species in the diet of cattle. Omphile (1997) reported that greater quantities of woody plants in the diets of wildlife during the dry seasons, reflect a period during which grass was less available in quantity and low in quality and animals may then supplement their diet from woody plants.

The dominance of woody species in the diet of goats confirms that this species is a browser. The ability of selectively foraging on browse ensures them of continuous supply of a high quality diet. Goats can withstand conditions were natural vegetation has degenerated because of overgrazing or bush encroachment while populations of grazers, like cattle, decline, because goats probably exhibit an opportunistic feeding strategy (Le Houérou 1980)
Cattle and sheep may have responded to the seasonal fluctuations in forage availability or quality by exploiting more foraging species during wet periods because most plant species were succulent and nutritive. However, some plant species were utilized more than others. As the dry period approached, the availability of heavily utilized species was reduced and animals satisfied themselves by consuming more of less preferred species. During dry periods, especially during the spring period, species diversity declined because annual plants

(grasses and forbs) disappeared. On the other hand, goats tended to concentrate on fewer plant species in response to the reduced forage quality.

The overlaps tended to be low during the growing seasons and high during dormant seasons because of the reduced plant diversity. Competition for forage between cattle, sheep and goats occurs more often during the dormant seasons and is more pronounced during years of subnormal rainfall when forage phytomass is low (chapter 5 and 7).

8.12 CONCLUSION

It is safe to say that browse constitutes a necessary and adequate supplement to herbage, in the dry seasons, as dry season grasses are extremely deficient in most nutrients needed to meet livestock maintenance requirements. Cattle are mainly grazers, but browse as well, in order to balance their diet. Browse plants remain higher in nutritional quality than grasses. Therefore, there is no need for browser (goat) to shift its diet seasonally as do cattle. An understanding of the variation of forage quality should aid in supplementary programmes for livestock. The combination of cattle and goats in range management may result in more efficient utilization of the range plants.

Overlaps of diets are generally high during dry seasons, because of the scarcity of forage, when the potentials of forage selections are restricted to limited species diversity and availability. The problems of competition for any plant species can be resolved by reducing the livestock units.