

## Foraging strategies of sheep and goats under semi-intensive management in Botswana

U.J. Omphile<sup>#</sup>, A.A. Aganga, K. Tshireletso and R. Nkele

Department of Animal Science & Production, Botswana College of Agriculture, Private Bag 0027 Gaborone, Botswana

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### Abstract

Diet selection of sheep and goats was determined seasonally using the microhistological technique to assess their trophic diversities, diet overlapping and preferences between the two species. The trophic diversities of both sheep and goats were higher in the wet than in the dry season. During both seasons sheep had higher trophic diversities than goats. Diet overlapping was higher during the dry season and lower during the wet season. Preference of forage by sheep and goats was influenced by season. Sheep, during the wet season preferred grasses and forbs and rejected browse, but preferred all forage classes during the dry season. Goats, on the other hand, preferred all forage classes during the wet season and preferred only browse during the dry season.

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**Keywords:** Diet overlap, trophic diversity, diet preference, goat, sheep

<sup>#</sup>Corresponding author. E-mail: uomphile@bca.bw

### Introduction

Most feeding habit studies suggest that sheep and goats prefer different forage classes (Papachristou & Nastis, 1993; O'Reagain & Grau, 1995; Posse *et al.*, 1996; Omphile *et al.*, 2003) and are therefore complementary in their foraging behaviour. The notion that there is no competition between sheep and goats, but rather an increased efficiency in forage utilization formed the basis of this study. We, therefore, determined the trophic diversities, diet overlapping, dietary preference of sheep and goats grazing on the Estate Management Unit Ranch in Botswana. The aim of the study was to contribute information that may be needed in developing sustainable management strategies for the ranch.

### Materials and Methods

The study area was at the Estate Management Unit Ranch, which is a 2500 ha government owned experimental farm located 10 km outside Gaborone in southeast Botswana. The climate is semi-arid and vegetation is primarily Acacia bush savanna characterized by an under cover of perennial grasses and annual forbs. Precipitation ranges from 350-500 mm/annum and occurs mainly between November and April. Temperatures generally range from 19 °C during the winter to 33 °C in summer with occasional winter frost and summer extremes of up to 38 °C.

Faecal pellets of sheep and goats were collected every second month from February 1999 to December 2000 and analyzed for relative plant species densities (%) via the microhistological procedure of Sparks & Malechek (1968). The results were used to determine trophic diversities, diet overlapping and species preferences of sheep and goats.

Trophic diversity indices ( $H'$ ) were calculated to indicate food niche breadth of each animal on the basis of the Shannon-Weiner function (Krebs, 1989) formula:

$$H' = \sum_{i=1}^n (P_i)(\log_e P_i),$$

where  $P_i$  = the % of total sample belonging to the  $i^{\text{th}}$  species in diet I ( $I=1,2,\dots,n$ );

$n$  = total number of species.

The index increases with an increasing number of plant species in the diet. A high trophic diversity index indicates that the herbivore does not rely on a few plant species for most of its diet, but has a broad food niche. Diet overlapping was calculated using the Simplified Morisita's index as proposed by Horn (1966):

$$CH = 2\sum_{ij} P_{ij} P_{ik} / \sum_{ij} P_{ij}^2 + \sum_{ik} P_{ik}^2,$$

where CH = Simplified Morisita index;

$P_{ij}$ ,  $P_{ik}$  = the proportion of resource in the total resources used by the two species ( $i = 1, 2, \dots, n$ );  
 $n$  = total # of resource states.

This index indicates potential for forage competition between two herbivores. The preference of a forage species by sheep and goats was determined by using the Electivity Index:

$$E_i = r_i - n_i / r_i + n_i$$

where  $E_i$  = Ivlev's electivity measure of species I;  
 $r_i$  = % of species in the diet;  
 $n_i$  = % of species in the range (Ivlev, 1961).

The index has values ranging from -1 to 1. Species with values close to 0 are consumed without regard to choice, while those with values close to -1 and 1 are rejected and preferred, respectively. Availability of forage in the range was determined by use of the line intercept procedure (Canfield, 1941).

Following calculations for the various foraging components, the main effects of seasons were determined using the GLM procedures of SAS (1995). All differences were tested at the 5% significance level unless indicated otherwise.

## Results and Discussion

The average trophic diversity of both sheep and goats (Table 1) was higher in the wet than in the dry season. Within season the trophic diversity of sheep varied from 25.3% during mid wet season to 17.3% by middle of the dry season, while that of goats reached the highest point (24.5%) during the wet season and declined to a dry season minimum of 14.7% at the peak of this season. The results showed that both sheep and goats responded to the reduced forage quality of the dry season by foraging on fewer plants of higher nutritive value. Alternatively, the trophic diversity of these animals during the wet season may have resulted from the greater abundance of a wider variety of forage plants. These findings support those of Omphile *et al.* (2003) on goats and relate to those of Bartolome *et al.* (1998) on sheep and goats. The significantly higher trophic diversity of sheep during the dry season compared to goats implies that sheep can better survive periods of suboptimal forage availability under conditions similar to those of the dry season at the study site.

**Table 1** Average trophic diversity ( $H' \times 100$ ) of bimonthly diets of sheep and goats at the Estate Management Unit Ranch, Gaborone, Botswana

| Species | Wet season |          |       |         | Dry season |        |         |         |
|---------|------------|----------|-------|---------|------------|--------|---------|---------|
|         | December   | February | April | Average | June       | August | October | Average |
| Sheep   | 19.7       | 25.3     | 21.5  | 22.2    | 17.3       | 18.6   | 21.2    | 19.0    |
| Goats   | 24.5       | 19.5     | 18.6  | 20.9    | 18.7       | 14.9   | 15.6    | 16.4    |

a,b column means with common superscripts do not differ ( $P > 0.05$ )

Diet overlapping between sheep and goats differed by seasons with a lower incidence of overlapping of 12.2% during the wet season than the higher one of 26.4% in the dry season when forage was more abundant. The overlapping intensified during the dry season but declined during the wet season. The abundance of forage during the wet season allowed both sheep and goats to confine their diet selection to the preferred plant species with little or no risk of nutritional stress. The liberalization of species of plants utilized by the two species reduced the potential for forage competition between them. However, as the dry season approached, both species changed their foraging tactics. Sheep, that relied on herbaceous forages during the wet season, incorporated more browse in their diets in the dry season. Goats did not forage much on forbs despite their relative abundance in the study area. It appears as if diet quality rather than quantity was responsible for the shift, because herbaceous plants in the study area decline in nutritive value more rapidly than browse (Pratchett *et al.*, 1977). Therefore, competition for forage between sheep and goats under conditions similar to those of the study area is more likely to occur during the dry than the wet seasons.

All plants isolated in the diets of sheep and goats were compared with their relative frequencies of occurrence in the range to determine the preference for individual plant species by the test animals. During the wet season sheep preferred grasses (0.59) and forbs (0.45) and rejected browse. Goats preferred shrubs

(0.23) and to a lesser extent grasses (0.19) and forbs (0.17). During the dry season shrubs were the most preferred forage class of both sheep (0.23) and goats (0.65). Goats rejected both grasses (-0.09) and forbs (-0.12) during the dry season while sheep showed a slight preference for them, in the order 0.11 and 0.15, respectively. The results demonstrated that the value of each forage class to sheep and goats depends on the season during which they are utilized.

## Conclusion

It is concluded that when sheep and goats are faced with similar opportunities of choice, the trophic diversities of both species are higher in the wet season than the dry season. Sheep and goats have similar trophic diversities during the wet season. However, the trophic diversity of sheep during the dry season is higher than that of goats for the same period. Diet overlapping more than doubled in the dry compared to the wet season. On the other hand, diet preferences varied by season when sheep rejected browse and preferred forbs and grass in the wet season, while goats rejected herbaceous plants and preferred browse in the dry season.

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