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AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 1
January 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2024; 24(1): 25288-25305 https://doi.org/10.18697/ajfand.126.22500

COMPARISON OF DIURNAL AND SEASONAL PATTERNS OF FEEDING BEHAVIOUR OF COWS AND CALVES AT NEUDAMM FARM IN NAMIBIA

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ABSTRACT

This paper aims to compare the seasonal and diurnal feeding behaviour of cows and calves at Neudamm Farm in central Namibia. Seasonal bite rates of cows, diurnal bites of cows and calves, and diet composition and preference were assessed and compared. Ten cows and ten calves were followed and observed from a distance, in the morning and in the afternoon. The observations were done on the same cows during the wet and dry seasons while calves were only observed during the wet season. The number of bites taken by each animal within a continuous period of 5 minutes was recorded. Herbaceous plant inventory was done in the foraging area using a step-point method. Each herbaceous plant intercepted was assessed for evidence of grazing and its life form was recorded. Bite rates were compared between morning and afternoon, and between seasons using a two-sample t-test. Preference for life forms and species were tested using a *Chi-Square* test. The morning bite rate of 38 bites/minute of cows during the wet season was significantly higher than that of the morning dry season of 34.9 bites/minute. This is attributed to the high abundance of nutritious forage resources during the wet season when animals did not have to do much searching compared to the dry season. Afternoon bite rates of cows did not significantly differ between seasons. Morning bite rates were significantly lower in the mornings than in the afternoons in winter. This was because cold morning temperatures slowed down animal feeding rates but increased with the progression of the day. Bite rates of calves did not significantly differ between morning and afternoon during the wet season because they were still learning to forage while being dependent on the mothers for milk. Cattle preferred *Schmidtia pappophoroides, Eragrostis trichophora, Heteropogon contortus* and *Eragrostis nindensis* due to their palatability and high grazing value. *Nidorella resedifolia*, despite being very abundant, was avoided because it contains a toxic alkaloid.

Key words: Bite rate, cows, calves, diet preference, herbaceous composition, Namibia, Neudamm farm

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INTRODUCTION

Agriculture in Namibia is severely limited by the shortage of moisture, variability of rainfall and regular occurrence of droughts, and low literacy accompanied by low management levels of farmers [1, 2]. Yet agriculture is a mainstay of ' 'Namibia's economy, not because it contributes much (just over 4 % in the last five years to the Gross domestic product (GDP), but because it provides livelihoods to the predominately rural population and earns valuable foreign exchange for the country [3]. Namibia's agricultural economy depends on extensive livestock ranching, which includes cattle, goats and sheep. Cattle are bred, raised and marketed directly off the natural vegetation with little external inputs such as supplementary feeding, intended only to correct nutritional deficiencies in the forage resource [4]. These potential forage items, however, show wide differences in nutritional value among the different species of plants and between plant parts [5]. The nutrient content and amounts of vegetation components vary considerably during the seasonal cycle. This is the case in African savannas, which are highly seasonal and dynamic, hence food resources change continuously due to environmental changes [6]. There is a need to sustain a nutrient intake to satisfy metabolic needs where large herbivores must make the necessary adjustments to their foraging behavior.

Cattle are herbivorous ruminants with a natural diet that consists only of plant materials. Among domesticated ruminants, cattle are regarded as selective feeders which feed more on herbs [7]. Cattle can distinguish between feeds by taste, smell, texture and brightness [8]. They learn to associate these characteristics with the consequences of eating the feeds concerned. The presence of toxins, nutrient deficiencies, or increases in specific nutrients cause animals to select a different type of feed. Calves learn to select suitable forage when grazing with their mothers by feeding on leafy material and avoiding plant stems or poisonous plants. Cattle increase their food intake from several sources during the dry season when there is a shortage of food. Moreover, these dietary preferences of cattle are influenced by seasonal changes in the environment and human intervention in stock management [9].

The productivity of cattle is dependent upon the ability to efficiently graze the available forage resources. Thus, understanding the grazing behaviour may assist land managers to properly allocate forage resources while preserving the biotic integrity of rangelands [10]. In addition, a good knowledge of the composition of the vegetation contributes to the successful management of large areas of natural rangelands. The extent to which the rangeland is being used and the changes that

take place depend on herbivores' response to differential use and other factors such as drought [11]. This is much more pronounced in semi-arid and arid rangelands where the availability and quality of forage become even more acute in the dry season. Therefore, to successfully manage animal diversity, it is crucial to understand their nutritional requirements in the habitat they occur and how they generally use their environment. Grazing animals usually play a role in shaping their environment, often having a more critical influence on the structure and productivity of their vegetation environment than is generally recognized [12]. For an animal to live, grow, reproduce and perform all its bodily functions, it must have nourishment.

Most behavioural studies on cattle have been carried out by visual observation of grazing activity and by examination of rumen contents and dung [13]. These studies have shown that feeding behaviour is influenced by factors of animal and plant interactions. According to cattle will usually graze for a maximum of 12 hours, taking up to 38 000 bites [14]. Herbage intake will be greater with a taller or denser sward than with a short, sparse one since more herbage can be taken in with each bite. In addition, cattle are more likely to graze grasses of more than 10 mm of height [15]. Studies on the foraging behaviour of feral cattle were conducted in Southwest Spain, where intake behaviour was influenced by extrinsic factors such as food abundance, type of plant and intrinsic factors (individual body size) [16].

Most studies have concentrated on the feeding behavior of adult cattle but not on calves, whereas the current study compared the feeding behavior of cows and calves during two seasons (dry and wet seasons), but the latter only during the wet season [17]. Recent studies have drawn a relationship between animal bite rates with weight, and forage availability without considering forage preference. Calves change how they spend their time as they age. Young calves spend a considerable amount of time lying down, but they spend less time resting as they get older. Similarly, calves with access to pasture begin to eat grass within the first few days of life and increase the time spent grazing as they age. Regardless of the management system, all calves are dependent on milk at the beginning of their lives [18]. At certain times of the year, grazing cattle often do not receive enough nutrients from grazed forages to meet production goals. Usually, protein is the first-limiting nutrient after forages reach reproductive maturity or dormancy [19]. Moreover, mineral supplementation is often provided to grazing cattle to maintain optimum reproductive performance, immunity, lactation, or growth. In this research, seasonal bite rates of cows and diurnal bite rates of cows and calves, and diet composition and preference were determined and evaluated. This information will assist farmers in the general management of free-ranging cattle.

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MATERIAL AND METHODS

Location of the Study area and Research design

The study was carried out at Neudamm Farm (Figure 1), which is situated about 40 km east of Windhoek along the highway to Gobabis town and about 10 km to Hosea Kutako International Airport. The area is in the Khomas Region at latitude 22º27'02″ S and longitude 17º21'38″ E and an altitude of 1856 m [20]. Neudamm farm was established in 1904-05 and extends over 10,187 hectares.

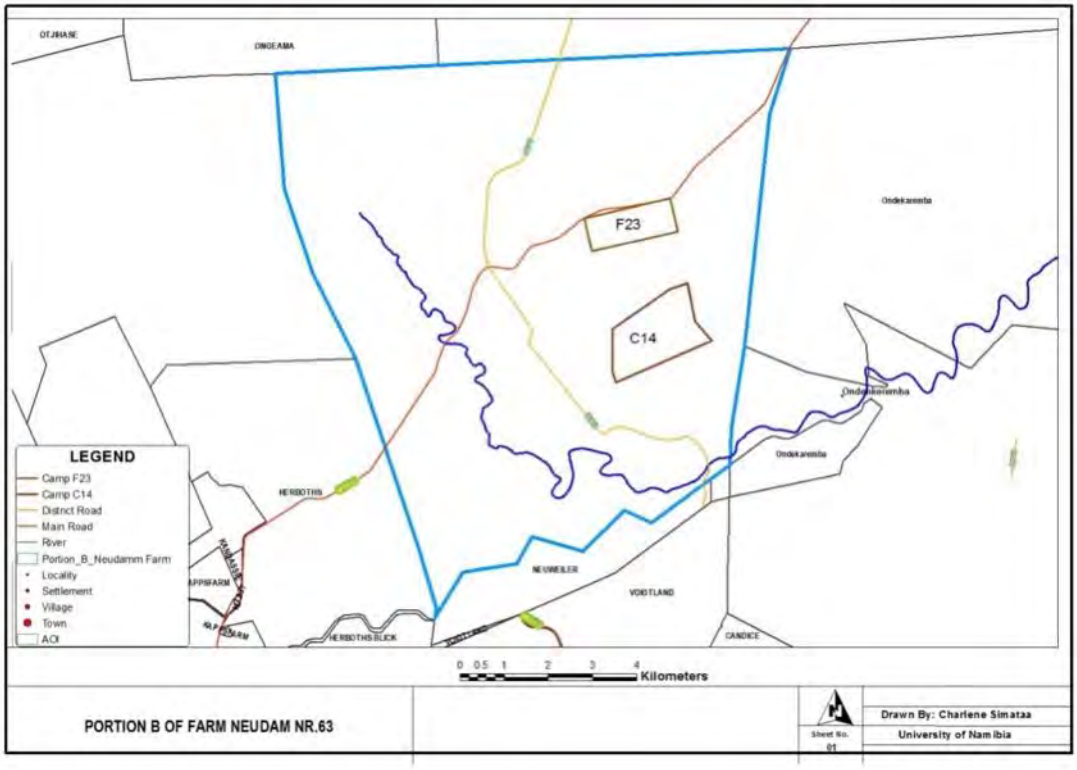

Figure 1: Location of Neudamm Farm showing the study Camps and surrounding areas

Camps C14 and F23 (Figure 1) were used as the sampling areas. A herd of Sanga cattle (Figures 2 and 3) was followed and observed from a distance (> 5m) for continuous periods of 5 minutes per day for each cow or calf using a pair of binoculars. Ten cows and ten calves were observed in the wet season (March), during the morning between 8 am to 11 am and in the afternoon between 2 pm to 4 pm. Only cows were observed in the dry season (August) because, by that time, calves had been weaned, and it was too difficult to have access to the calves. The number of bites taken during the 5 minutes sessions per animal were counted and recorded.

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Figure 2: Observation of cows and calves in the wet season in Camp C14

Figure 3: Observation of cows in camp F23 in the dry season

Inventories of plants and assessment of grazing

For this study, only herbaceous plants (grasses, sedges, forbs) were considered because cattle are predominantly grazers. Browsing bite rates were not recorded during data collection. Inventories of herbaceous plants were carried out in the area where the animals were feeding. Herbaceous vegetation was inventoried using a step-point method [21]. This gave the relative abundance and species composition and grazing assessment. These assessments were done during the growing (wet) season. Fourteen walking line transects were demarcated with 10 steps between sampling points on each transect. A total of 378 step-points were

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done during each season. At each step-point, the herbaceous plant species intercepted was identified and assessed for evidence of grazing.

Data Analysis

Bite rates were expressed on a per-minute basis. The data on bite rates were tested for normality using a Kolmogorov-Smirnov (K-S) test and were found to be normally distributed. A two-sample t-test was used to determine if there was a significant difference between the morning and afternoon bite rates of both cows and calves (separately), as well as between wet and dry seasons. Diet preference was determined by comparing the proportional abundance of species in the rangeland, and the proportion grazed using a *Chi-square* test of Association. To determine if animals preferred any given life form (grass, forb or sedge) a *Chi-square* test of Association was also performed on the number of grazed plants per life form.

RESULTS AND DISCUSSION

Differences in bite rates of cows and calves

The wet season morning bite rates of cows were significantly higher than those of the dry season ($t = 2.074$, $df = 22$, $p < 0.01$; Figure 4). Afternoon bite rates of cows did not significantly differ between seasons ($t = 2.0484$, $df = 28$, $p > 0.05$; Figure 4). The morning bite rates of cows did not differ significantly from that of the afternoon during the wet season ($t = 2.0452$, $df = 29$, $p > 0.05$) (Figure 4). The afternoon bite rate of cows was significantly higher than those of the morning during the dry season ($t = 2.002$, $df = 57$, $p < 0.01$; Figure 4). The morning bite rate of calves in during the wet season, did not differ significantly from that of the afternoon ($t = 2.1314$, $df = 15$, $p > 0.05$; Figure 5).

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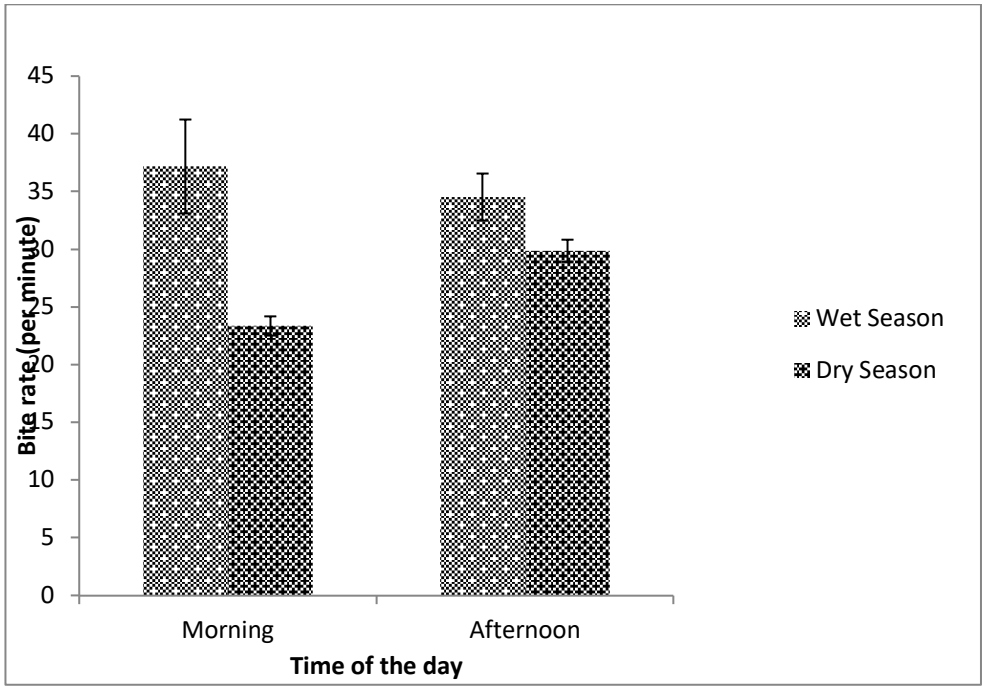

Figure 4: A comparison of the bite rates of cows between wet and dry seasons during morning and afternoon at Neudamm farm

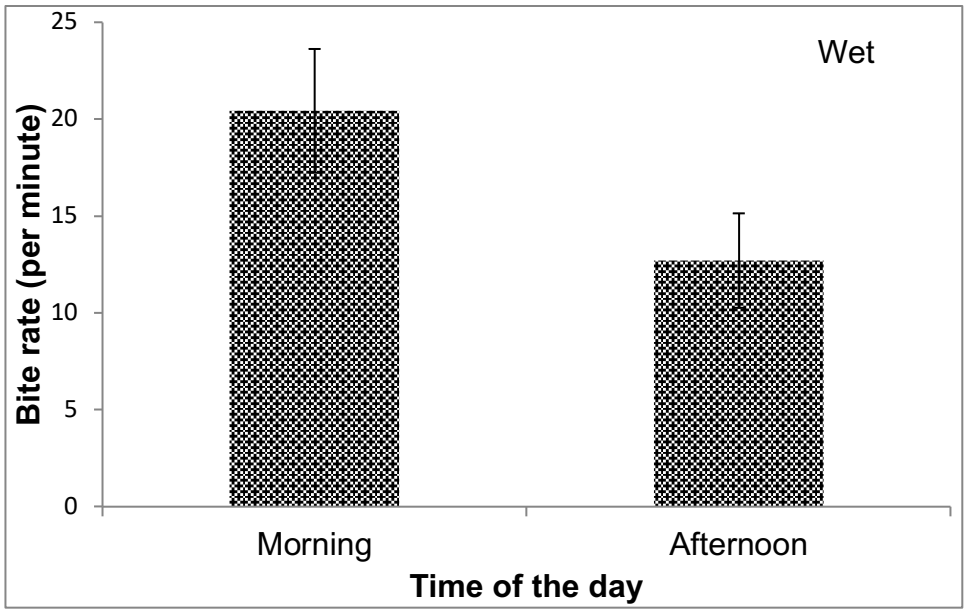

Figure 5: Comparison of bite rates of calves between morning and afternoon during the wet season at Neudamm farm

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From Figure 4, it is evident that the wet season bite rate of cows is slightly higher than that of the dry season because of the availability of enough forage and comfortable weather conditions for foraging during the wet season. However, forage resources tend to decline in diversity, abundance, and quality during the dry season. This leads to more selectivity of dietary items by cows. Increased selectivity resulted in a decline in bite rates of the cows during the dry season compared to the wet season. This result is contrary to the increased bite rates of cattle at the expense of diet quality recorded during the dry season in central Zimbabwe [22]. These contrasting results imply that the local foraging environment may present other determinants influencing bite rates. In addition, poor forage quality forced cows to move more dispersedly during the dry season. These behavioural changes can have negative effects on animal productivity. The bite rate of herbivores can be limited either by the search and rate of encounter with food items or by chewing and swallowing time [23]. Hence, during the dry season, cows expanded their diet to include less palatable species. That is why supplementary feeds are normally given to cattle at Neudamm to correct specific nutrient deficiencies in the rangeland, particularly during the dry season.

During the dry season, the negative effect of low-quality forage led to a decrease in the bite rates of cows because, even if cows wanted to eat more, they could not find enough feed to meet their requirements. Under conditions where feed is difficult to harvest, cows compensate for the small size of bite eaten by increasing the time spent grazing. The wet season is warmer in the morning (than winter mornings), so cows are more active and can forage much during that time. However, during the early dry season, the weather is cold, so animals become less active and their bite rates decline because they wait for the weather to become more favourable (warmer). Cattle are less adapted to dry conditions, hence they need more water (than other domesticated animals, such as sheep and goats, which are better adapted to arid conditions [24].

There was no significant difference in afternoon bite rates between the wet and dry seasons (Figure 5). This is because during both seasons, after feeding in the morning, cows have to chew the cud before commencing to feed again later in the afternoon. The rumen structure limits what they eat in the afternoon, irrespective of the season because it increases food retention time. Feeding in the afternoon is mainly influenced by the quantity eaten in the morning and the day's temperature.

Grazing ruminants frequently exhibit a diurnal rhythm, grazing during daylight hours with high peaks of grazing activity close to dawn and the other in the late afternoon [13]. The bite rates of cows showed a slight but non-significant difference

between the afternoon and the morning during the wet season at Neudamm farm. This unsurprising trend is because forage resources are abundant and widespread enough due to the wet environment. However, the morning bite rate of cows was significantly lower than that of the afternoon during the dry season. However, the morning bite rate of cows was significantly lower than that of the afternoon during the dry season. This is because cows might have grazed overnight due to lower temperatures, so in the morning, they do not graze that much, leading to a decrease in the morning bite rates. Cattle have been reported to graze during the night when temperatures are lower and reduce their grazing time during hot and humid days [13]. Another reason could be that when the researchers arrived in the Camp early in the morning the cows were not significantly foraging because it was too early and cold for them. When cattle are cold, they may stand around waiting for sunshine instead of grazing, and this leads to a decrease in the morning bite rates. Seasonal effects such as shifts in sunrise and sunset (which affect day length) influence the timing and duration of grazing. The average bite rates of cows recorded during this study conform to the general observations elsewhere of 30-60 bites per minute [25].

The bite rates of calves were not significantly different between the morning and afternoon during the wet season. This is because the calves were both grazing as well as feeding from their mothers during both times. The feed resources from both sources were enough for their requirements at any time of the day. Their average bite rates were outside the bite rate range of their mothers, something attributable to the fact that they were still learning to forage. In calves, grazing time increases rapidly as the milk supply decreases. A calf is a single-stomach animal; its nutrition is more specialized than that of the adult ruminant [26]. The nutritional needs of the suckling calf increase as its body mass increases and initiates grazing at some point as the mother's milk production decreases while the calf's needs continue to rise.

Species preference and diet composition

A total of 27 different species of grasses, sedges and forbs were recorded in the rangeland (Table 1), where 16 (59 %) were grazed. These included 12 species of grasses, of which 11(92 %) were grazed. Twelve species encountered in the rangeland were forbs, of which 4 (33 %) were grazed; sedge species were 3, and 1 (33 %) was grazed. Out of the 27 species encountered, a forb *Nidorella resedifolia* formed the largest proportional occurrence (36 %) but it was not preferred, as it was not grazed in direct proportion to its occurrence in the rangeland. This species is reported to contain a toxic alkaloid and is non-palatable, which is why it was not preferred [27, 28]. Most other grazed species were preferred since they were

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grazed at higher proportions than their occurrence in the rangeland (Table 1). This shows that the animals deliberately looked for them. *Ruellia diversifolia, Aizoon asbestinum, Lobelia serinus, Chlorophytum calyptrocarpum, Pergularia daemia, Cyperus esculentus, Stipagrostis ciliata* and *Stipagrostis uniplumis var. uniplumis* had the lowest frequency of occurrence (less than 1 %; Table1).

The most frequently grazed graminoids were *Eragrostis trichophora, Heteropogon contortus, Schmidtia pappophoroides, Cymbopogon caesius* and *Eragrostis bicolor*, while *Nidorella resedifolia* and *Ocimum canum* (forbs) were avoided. Cyperus fulgens was the most frequently grazed sedge by cattle. *Schmidtia pappophoroides* was preferred because it is regarded as a valuable, palatable and highly desirable grass. *Microchloa caffra* is a pioneer grass that is palatable, *Eragrostis nindensis* is a valuable and palatable grass, both of which also formed a relatively significant part of the diet of cows [29] . Overall, the diet of cows consisted of sixteen herbaceous plants, 75 % of which were grasses. This may, however, be an underestimate of the complete diet since some plants were observed to be completely uprooted during grazing because of the soft soils during the wet season.

Preference for life forms

The cattle diet was composed of 44.5 % graminoides, 44.4 % forbs and 11.1 % sedge species. The *Chi-square*d test indicates that cattle preferred grasses compared to forbs and sedges since grasses were grazed at higher proportions than their occurrence in the rangeland ($\chi^2 = 9.396$, df = 2, $p < 0.05$) (Figure 6). *Nidorella resedifolia* was highly abundant in the grazing area, but only 9 % was grazed. This is because the tall, reproductive summer form of *Nidorella resedifolia* is not palatable [28]. Livestock avoid it if they have more palatable plants to choose from, such as *Monechma genistifolium, Eragrostis trichophora, Stipagrostis uniplumis, Schmidtia pappophoroides,* and *Cyperus rotundus.*

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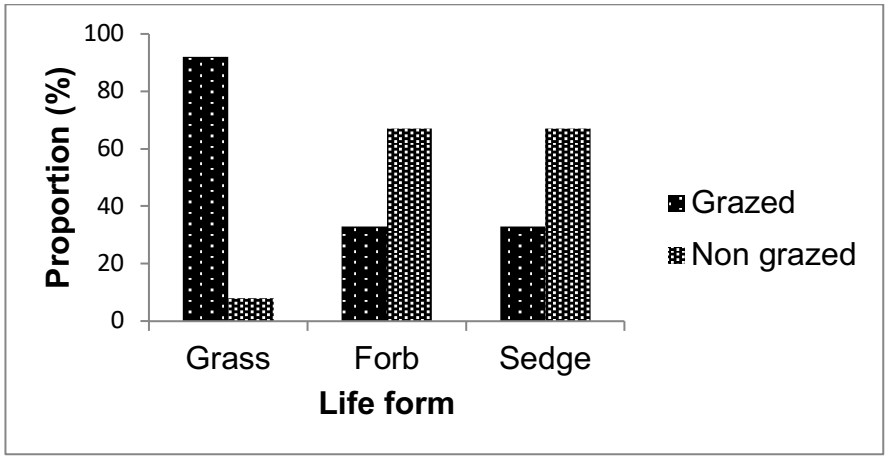

Figure 6: Proportions of grazed and non-grazed grasses, forbs and sedges

Cattle tend to show the ability to discriminate among life forms (grasses, forbs and sedges). Grasses were the dominant life form and were strongly selected, most likely because they were the most frequently encountered life form among the herbaceous plants. Most of the grasses present such as *Schmidtia papophoroides, Eragrostis nindensis, Eragrostis trichophora, Heteropogon contortus,* and *Stipagrostis uniplumis* are of medium to high grazing value [30]. Though cattle are mixed feeders, they tend to show a preference for grasses over other life forms [31, 32]. Cattle eat combinations of grasses and forbs, and even dead sward because of the less selective nature of their feeding style of wrapping the tongue around lumps of herbaceous plants. That is why sometimes even non-preferred material may end up being ingested.

CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

This study which was conducted in field conditions demonstrated that it is possible to make direct observations on animal feeding behaviour with respect to bite rates and diet selectivity at life form and species levels. The feeding behaviour of cows varied between wet and dry seasons, largely influenced by the availability of forage resources. The morning bite rates of cows during the wet season were significantly higher than those of the dry season because of more forage resource abundance which offered better choices during the wet season. The bite rates of cows did not differ significantly between morning and afternoon during the wet season because forage resources were abundant and widespread enough, coupled with comfortable weather conditions during that season. During the dry season however, morning bite rates were significantly lower than afternoon bite rates because cows might have grazed overnight taking advantage of lower temperatures, so in the morning, they did not graze as much. Bite rates of calves did not significantly differ between morning and afternoon during the wet season

because they were still learning to graze the abundant forage resources while also feeding from their mothers throughout the day. Cows showed preference for grasses over forbs and sedges because grass species were more abundant, most of which were of medium to high grazing value.

ACKNOWLEDGEMENTS

The authors would like to sincerely thank the University of Namibia (UNAM) for allowing the study to be conducted at the institution's Farm and for providing funding under an internal UNAM Research Grant.

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Table 1: Diet composition and preference of cattle in the rangeland of Neudamm farm (Wet season)

Species	Life form	Proportional occurrence (%)	Proportional grazed (%)
Aizoon asbestinum	Forb	0.38	100
Aristida congesta	Grass	3.77	30
Chlorophytum calyptocarpum	Forb	0.38	100
Cleome angustifolia	Forb	0.75	0
Cymbopogon caesius	Grass	0.75	50
Cyperus esculentus	Sedge	0.38	0
Cyperus fulgens	Sedge	3.02	50
Dicoma anomala	Forb	0.38	0
Eragrostis bicolor	Grass	0.75	50
Eragrostis nindensis	Grass	7.92	35
Eragrostis superba	Grass	1.13	33
Eragrostis trichophora	Grass	0.75	100
Fimbristylis hispidula	Sedge	1.13	0
Geigeria ornativa	Forb	0.75	0
Heteropogon contortus	Grass	0.75	50
Lobelia erinus	Forb	0.75	0
Melinis repens	Grass	0.38	25
Microchloa caffra	Grass	6.42	18
Monechma genistifolium	Forb	0.75	100
Nidorella resedifolia	Forb	35.85	9
Ocimum canum	Forb	1.51	0
Oxalis obliquifolia	Forb	0.75	0
Pergularia daemia	Forb	0.38	0
Ruellia diversifolia	Forb	1.51	0
Schmidtia pappophoroides	Grass	27.17	57
Stipagrostis ciliata	Grass	1.13	0
Stipagrostis uniplumis var. uniplumis	Grass	0.38	100

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