DIET SELECTION OF FREE RANGING HORSES IN THE HIGHLAND SAVANNA OF NAMIBIA: A CASE STUDY AT SEEIS FARM

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ABSTRACT

The diet selection of free ranging horses was determined at Seeis farm during June, 2004. Direct animal observation technique, technically known as the bite count method, was used and the bites taken from various plant species were compared to the percentage occurrence of those species available in a natural range as determined by systematic step point sampling. Data were analysed using Microsoft Excel version 1997. The horses ate grass species, herbs, bushes, shrubs, bark of the tree, and fallen grass materials. The principal forage was *Stipagrostis uniplumis* (24,7 %) and Eragrostis rotifer (18,7 %). The most preferred forage was the fallen grass material at 30,1 %. There are differences among means in the chemical composition of different forage species, utilized with regard to dry matter, ash, crude fibre and crude protein. All grass species tend to have little fat content that ranges from 1 % to 1,3 %. *Acacia mellifera* leaves have the highest fat content among forage species utilized by the horses.

INTRODUCTION

Livestock production contributes about 10 % to 15 % to the Gross Domestic Product, depending on annual rainfall. According to the National Planning Agricultural Census (1997), the horse population in 1994/95 was about 19 886. In Namibia, horses are used for recreation (i.e. racing, sport and riding), driving carts, hunting, pulling and transporting heavy equipment, and for ranching purposes. Horse breeders breed mares and sell the offspring that can be trained for horseracing, shows as well as for special cultural events. The season in which animals graze the given area, is important. Diet will tend to change a little with the changing of the season, because often animals eat what is most nutritious or available during the specific season (Tainton, 1988). Rangeland is a very heterogeneous pasture with a multistratified distribution of forage resources, subject to important quantitative and qualities variations which depend on the season (Tainton, 1988). The quantity of forage eaten each day depends on the time spent grazing, the rate of biting, and the size of each bite (Minson, 1990). Nutrient intake in both quality and quantity of herbage selected are virtually impossible to measure directly; therefore chemical analysis has to be done on the various plant samples so that the nutrient content can be determined (Forbes, 1995). Diet selection research has been done by many others on sheep, goats and cattle in the highland savanna of Namibia (Kavendjii, 1999; Kamupingene, 2000 and Rothauge, 2006), but there is little or no information available on diet selection of a horse. Feeding and nutrition are important aspects in any farm animal. The ability of herbage to satisfy animal requirements for growth, and or production, maintenance and reproduction depends largely on the nutritive value (chemical composition) of the herbage (Tainton, 1988). The information on diet selection will guide farmers with proper range management plans, for example to know the most preferred forage species for the particular animal species. The main objectives of the study is to investigate what a horse really eats in an extensive grazing condition, identify principal and preferred forages species of the vegetation and to analyse the selected specific plant parts consumed and to know what nutrients are lacking in the horse's diet, to enable the farmer to supplement them.

MATERIALS AND METHODS

Trial site

The experimental research was conducted at Seeis farm, situated about 47 km east of Windhoek. The farm is privately owned by Dr Wolfgang Späth and it started operating in 1994. The farm is 2 000 hectares in size (17 camps/paddocks), and there are about 133 horses that are being kept there. The annual rainfall is about 300 mm per annum. The area is part of the Highland savannah and the overall carrying capacity for highland savannah ranges from 8 to 10 ha/LSU in good years and 18 ha/LSU to more than 20 ha/LSU in bad years (Giess, 1971). The data was collected at the end of the growing season (June).

Methodology of the botanical composition and ground cover

The experiment was conducted in an un-grazed paddock. Immediately before a treatment horse herd was allowed to graze in the experimental paddock, its botanical composition was determined by a systematically placed step-point sampling method. A three-metre-long iron rod was placed along the paddock's diagonal transect from one corner of the paddock to the opposite one. During the determination of the abundance of plants along the treatment camp's diagonal transect, the canopy cover of the soil was determined by letting the three metre iron rod fall freely onto the surface, classifying the exact point of impact of the falling rod either as "bare" or "covered", depending on whether it struck, or fell under, a plant canopy or not. Thereafter the botanical abundance of all plant species encountered was recorded.

Methodology of the carrying capacity

Before the horses were introduced into the experimental paddock, the herbaceous yield was determined by clipping 1 m² evenly spaced quadrants along the transect. This was done by counting 40 steps of the observer's pace between each quadrant to be cut. About 45 quadrants were harvested along the diagonal transect of the experimental paddock from one opposite corner of the paddock to the other. The quadrants were placed at random. This was achieved by throwing the quadrant backwards over the observer's head so that the operator did not see where it fell and therefore could not select the patch to be sampled. At harvesting, the plant material was clipped at ground level using a pair of scissors. These plant materials were sorted into two bags, respectively into palatable and unpalatable plant species. The carrying capacity of the camp was calculated, expressed in kilogram per animal biomass.

Methodology of the diet selection observations

Firstly, an adaptation period of about 3 to 4 days allowed the observer to familiarise herself with the existing vegetation in the paddock i.e. grass species and shrubs. During the adaptation period the observer was enabled to get accustomed to the horse herd. The bite counts method was used in this experiment to quantify the relative number of different classes of plant species selected. The bite counting method was originally developed for goats (Narjisse, 1991), but was found to be applicable to horses too (Aganga, lETSO, & AGANGA, 2000). It is believed that animals are more actively feeding during morning and afternoon hours because those are the times of the day when it is cool (Narjisse, 1991).

In a herd of 22, six horses are randomly selected for each treatment and each horse is observed for a period of 10 minutes. The observation distance was three metres or less. During the ten minutes of observation, all bites taken were counted, and all plant parts or organs utilised were recorded. Should the horse have interrupted his feeding session in the ten minute observation period, the stopwatch was stopped and recording only resumed when the horse restarted feeding. In such a case, observation continued until the full 10 minute observation period of feeding has been reached. This procedure was repeated on three consecutive days, both in the morning and afternoon per treatment.

From these data analysed, the dietary abundance of every forage species was calculated as a percentage based on the frequency of its occurrence in the diet.

Sample collection and Nutrient analysis

After diet selection observation, all samples from every utilised forage plant species collected, (either by hand-clipping or by using a pair of scissors in a manner imitating the observed selection pattern of horses during bite counting, were collected. These samples were immediately sealed in small plastic bags to retain their field moisture content (although some plants were already dry), weighed and oven-dried, grounded through a 1 mm sieve and subjected to standard chemical analysis to determine their nutritive value. This is presuming to indicate the nutritive value of the selected diet.

Nutrient analysis was done using the proximate system of analysis. Each single sample was used to determine dry matter by heating the sample to extract moisture from the sample at a temperature of about 105 °C. Ash was determined by burning the samples in a muffle furnace at 500 °C to 600 °C for 2 to 3 hours. Crude protein was determined by the Kjeldahl method. Determination of Ether Extract (lipid/fat) was done by using the Sox-let fat extraction apparatus for a period of 12 hours. Crude fiber was obtained by boiling the sample in weak acid and weak alkaline. Lastly, the Nitrogen-Free-Extract was calculated by subtracting the sum of all the other fractions above (NFE % = 100 – % Ash – % CF – % EE – % CP).

RESULTS AND DISCUSSION

Botanical survey

The botanical composition was determined before the herd of horses was introduced into the paddock. The following table shows all plant species encountered

Table 1. Botanical composition of the experimental paddock

Species	Strikes	Frequency (%)
Acacia mellifera	60	12,2
Anthizoma angustifolia	2	0,4
Aristida congesta	3	0,6
Aristida effusa	22	4,5
Aristida meridionalis	3	0,6
Boscia albintruca	3	0,6
Cenchrus ciliaris	36	7,3
Cyperus spp.	1	0,2
Enneapogon cenchroides	77	15,7
Eragrostis echinochloidea	1	0,2
Eragrostis rotifer	91	18,5
Fallen grasses	9	1,8
Grewia flava	3	0,6
Herbs (unknown)	6	1,2
Melinis repens	7	1,4
Pogonarthria fleckii	23	4,7
Schmidtia pappophoroides	9	1,8
Stipagrostis uniplumis	119	24,2
Tribulus terrestris	4	0,8
Unidentified grasses	9	1,8
Urochloa brachyura	3	0,6
Total	491	100

The experimental paddock was dominated by *Stipagrostis uniplumis*, *Eragrostis rotifer* and *Enneapogon cenchroides* grass species, as seen in the Table 1. Trees, shrubs and herbs contributed the least to the botanical composition of the experimental site.

Table 2. Ground cover and bare area percentage

Ground surface	Strikes	% Covered/bare
Bare	144	22,7
Covered ground	491	77,3
Total	635	100 %

The frequencies of species occurrence are depicted in Table 1 with the general ground cover, partitioned into bare patches and covered area, reported in Table 2. Various grass species, herbs, shrubs and bushes contributed to the covered portion. It was observed that 77,3 % of the paddock/camp was covered in forage and 22,7 % consisted of bare patches. The used paddock had enough vegetation available for grazing.

Diet selection

Table 3 represents the total number of bites per forage species utilised, during the feeding of horses over the four days of observation in both morning and afternoon sessions.

Table 3. Total number of bites per forage species and their parts utilised by horses

Species	Bites	Frequency (%)	Plant part utilised
Angustifolia anthizoma	109	1,09	Leaves
Aristida congesta	28	0,3	Inflores.
Aristida effusa	73	0,7	Inflores.
Acacia mellifera (bark)	102	1,02	Bark
Acacia mellifera (fallen leaves)	82	0,82	Fallen leaves
Boscia albintruca	105	1,05	Bark
Cenchrus ciliaris	506	5,1	Inflores.
Cyperus spp.	3	0,03	Inflores.
Enneapogon cenchroides	754	7,6	Inflores.
Eragrostis echinochloidea	0	0	Inflores.
Eragrostis rotifer	1870	18,7	Inflores.
Fallen grasses	3093	30,1	Inflores.
Grewia flava	10	0,1	Leaves
Melinis repens	12	0,12	Inflores.
Pogonarthria fleckii	115	1,2	Inflores.
Schmidtia pappophoroides	34	0,3	Inflores.
Stipagrostis uniplumis	2466	24,7	Inflores.
Tribulus terrestris	524	5,3	Whole plant
Urochloa brachyura	94	0,9	Inflores.
Total	9980	100%	

Inflores. = Inflorescence

There is a significant difference among the species that were consumed more when compared to those less utilised. Among all forage species utilised, fallen grass materials obtained the highest bite frequency (30,1 %). *Stipagrostis uniplumis* and *Eragrostis rotifer* followed with 24,7 % and 18,7 %, respectively. The principal species are those forage species that contributed the most to the animal's diet, namely; *S. uniplumis* and *E. rotifer.* In Table 3, fallen grass material was consumed for 30,1 % more than they had occurred (1,8 % from Table 1) in the paddock. This means fallen materials were the preferred forage by the horses.

Dietary preferences

The diet preference ratio is determined by dividing dietary abundance (%) over the botanical abundance (%).

Table 4. Comparison of dietary and botanical abundance of different forages

Species	Botanical abundance (%)	Diet abundance (%)	Dietary preference ratio
Angustifolia anthizoma	0,42	1,09	2,60
Aristida congesta	0,63	0,28	0,45
Aristida effusa	4,62	0,73	0,16
Aristida meridionalis	0,63	0	0
Acacia mellifera	12,61	1,84	0,15
Boscia albintruca	0,63	1,05	1,67
Cenchrus ciliaris	7,56	5,07	0,67
Cyperus spp.	0,21	0,03	0,14
Enneapogon cenchloides	16,18	7,56	0,47
Eragrostis echinochloidea	0,21	0	0
Eragrostis rotifer	19,12	18,74	0,98
Fallen grasses	1,89	30,99	16,40
Grewia flava	0,63	0,10	0,16
Melinis repens	1,47	0,12	0,08
Pogonathria fleckii	4,83	1,15	0,24
Schmidtia pappophoroides	1,89	0,34	0,18
Stipagrostis uniplumis	25,00	24,71	0,99
Tribulus terrestris	0,84	5,25	6,25
Urochloa branchyura	0,63	0,94	1,49
Total	100	100	33,08

Key: DPR > 1,0 = preferred forage species

According to Table 4, fallen grass materials are more preferred with a dietary ratio of 16,40 followed by *T. Terrestris* (6,25). Also, *A. angustifolia* and *U. brachyura* were consumed more than they appeared in the experimental paddock with 2,60 and 1,49, respectively.

Table 5. Tests of between subjects' effects, to show whether there are differences among species, time (1st to 4th), horses and day (morning versus afternoon)

Source	df	F	Significance	*P*
Species	16	6,870	0,000	< 0,01
Time	1	0,617	0,433	not significant
Horse	5	0,923	0,446	not significant
Day	3	4,377	0,005	< 0,01

According to the table above, the statistical analysis confirmed that there are highly significant differences ($P < 0{,}01$) among species consumed, unlike among horses and time used for the observation.

Chemical composition of plant parts utilised by horses

Table 6 shows the average mean values of forages obtained during chemical analysis using the proximate system of analysis.

Chemical analysis

As indicated in Table 6, there are differences among means in the chemical composition of different forage species utilised, with regard to Dry Matter, Ash, Crude Fibre and Crude Protein. All grass species tend to have little fat content that ranges from 1 % to 1,3 %. *Acacia mellifera* leaves have the highest fat content among forage species utilised by the horses. A mature 700 kg lactating mare with a foal requires 13 % to 14 % Crude Protein (National Research Council, 1989). Knowing what a horse requires per day, and how much chemical composition is available in all forage species utilised, will not enable one to determine how much is lacking in the diet. This is because, for example, the amount of Crude Fibre consumed per day was not measured.

Carrying capacity

The carrying capacity estimations indicated that the experimental paddock is capable of keeping 16 Large Stock Unit (LSU) for a period of one year without veld deterioration or loss of animal condition. The paddock has a potential of sustaining 95 mares plus foals for a period of 60 days, but this farmer allocated only 22 mares with foals for 60 days, resulting in 23,2 % paddock utilisation. According to Meissner, Hofmeyr, Van Rensburg, & Pienaar, 1983, a 700 kg mare with a foal need 1,65 LSU, assuming that the mare consumes about 3 % of its body mass per day. The following calculation indicates the procedure for the calculation of the carrying capacity of the experimental paddock:

Table 6. Chemical composition of forage species utilised by horses

Species	DM %	ASH %	FAT %	CF %	CP %	NFE %
Aristida effusa	98,2^{a}	6,6^{ghi}	1,0^{b}	37,6^{ef}	5,4^{efgh}	49,5^{bc}
Angustifolia anthizoma	93,7^{cdef}	14,2^{c}	1,4^{b}	31,0^{h}	10,2^{cd}	42,3^{d}
Aristida congesta	96,2^{b}	3,4^{j}	1,1^{b}	33,4^{gh}	5,9^{efgh}	56,4^{a}
Acacia mellifera bark	92,0^{fg}	10,2^{a}	1,3^{b}	70,2^{b}	13,2^{b}	5,2^{i}
Acacia mellifera leaves	94,0^{ced}	25,0^{e}	3,1^{a}	19,0^{j}	9,2^{d}	43,8^{d}
Boscia albatrica	92,9^{ef}	6,4^{ghi}	0,5^{b}	74,8^{a}	16,5^{a}	1,9^{j}
Cenchrus ciliaris	95,4^{bc}	8,9^{ef}	1,1^{b}	36,3^{fg}	6,8^{ef}	47,0^{c}
Cysperus spp.	95,1^{bcd}	20,0^{b}	1,4^{b}	38,9^{ef}	5,3^{fgh}	34,8^{f}
Enneapogon cenchroides	96,3^{b}	18,8^{b}	1,5^{b}	49,9^{c}	6,3^{efgh}	23,6^{h}
Eragrostis echinochloidea	96,1^{b}	7,6f^{g}	1,0^{b}	46,9^{cd}	5,1^{fgh}	38,8^{e}
Eragrostis rotifer	95,1^{bcd}	6,1^{hi}	1,1^{b}	45,9^{d}	5,7^{efg}h	41,4^{d}
Grewia flava	93,4^{def}	12,8^{d}	1,1^{b}	25,1^{i}	11,2^{c}	49,8^{b}
Melinis repens	94,8^{bcd}	7,3^{gh}	1,4^{b}	47,0^{cd}	6,5^{efg}	38,0^{e}
Pogonathria fleckii	95,3^{cb}	5,4^{i}	1,3^{b}	43,8^{d}	5,8^{efgh}	43,7^{d}
Schmidhia pappophoroides	90,7^{g}	7,6^{fg}	1,3^{b}	38,8^{ef}	4,6^{h}	47,7^{bc}
Stipagrostis uniplumis	94,8^{bcd}	5,8^{hi}	0,8^{b}	39,9^{ef}	6,5^{efg}	47,1^{c}
Tribulus terrestris	95,0^{bcd}	12,3^{d}	1,5^{b}	50,0^{c}	9,0^{d}	28,9^{g}
Urochloa brachyura	96,1^{b}	12,3^{d}	0,7^{b}	32,1^{h}	7,2^{e}	47,8^{bc}
Mean ± s.e.	94,8 ± 0,53	10,1 ± 0,46	1,2 ± 0,35	41,9 ± 1,12	7,6 ± 0,53	39,2 ± 0,76
Palatable	94,8^{bcd}	6,1^{hi}	1,2^{b}	37,3^{ef}	6,6^{efg}	48,9^{bc}
Unpalatable	95,8^{b}	6,1^{hi}	1,1^{b}	40,3^{e}	4,8^{gh}	47,9^{bc}

^{abcdefg} Within the column, means with similar superscripts do not differ ($P < 0{,}05$)

Step 1:
DM grass yield = 10 000 m² x 3485,3 g = 774,51 kg/ha 45 m²

Step 2:
Yield after estimated loss from trampling, insects and termites, is 35 % (774,51 kg x 0,65) = 503,43 kg

Step 3:
Estimated utilisation 50 % (503,43 x 0,5) = 251,72 kg DM/ha
Therefore, 500 ha would yield = 125 860,05 kg DM available

Step 4:
A 700 kg mare with foal needs 1,65 LSU (Meissner *et al.*, 1983), 1,65 LSU x 13,5 kg/LSU (3 % x 450 kg)
= 22,28 kg/mare and foal/day
Therefore, this 500 ha paddock offers forage for

$$\frac{125\ 860{,}05\text{kg}}{22{,}28\text{ kg/mare/day}} = 5\ 650{,}28\text{ mare-days}$$

Step 5:
Attempted grazing period 2 months (60 days)

$$\frac{5\ 650{,}28\text{ mare-days}}{60\text{ days}} = 94{,}71\ (95)\text{ mares for 60 days}$$

22 mares + foals for 60 days, 22/95 x 100 = 23,2 % utilisation

The camp was underutilised. Thus, the recommendation was to put more mares into the camp, or to prolong the grazing period.

Mare and foal on 500 ha for 1 year:

700 kg x 3 % = 21 kg/day x 365 days = 7 665 kg DM/year

$$\frac{125\ 860{,}05\text{ kg available on 500 ha paddock}}{7\ 665\text{ kg}}$$
= 16 mares on 500 ha

Carrying capacity on conventional terms:

$$\frac{500\text{ ha}}{16\text{ mares}} = 1\text{ LSU}/30{,}45\text{ ha (700 kg)}$$

$$\frac{125{,}72\text{ kg DM/ha}}{10{,}95\text{ kg DM/365 days}} = 22{,}98\text{ kg animal biomass/ha}$$

CONCLUSION

In arid and semi-arid areas, horses eat a wide variety of feeds. Horses graze; eat standing hay or fallen grasses, herbs, shrubs and the bark of trees. Horses have teeth and lips that permit them to graze close to the ground i.e. they are able to pick up preferred fallen grass material and herbs from the ground. Therefore, horses are grazers as well as browsers. The principal forage is *Stipagristis uniplumis* (climax) and *Eragrostis rotifer* (sub-climax) palatable, perennial grass species.

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EFFECTIVE COMMUNICATION OF CLIMATE CHANGE BY EXTENSION AGENTS

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ABSTRACT

Climate change has often been discussed at conferences, and in meetings and workshops, but it is not known whether society is aware of its continuing vulnerability to this global phenomenon. Agriculture is one of the sectors most affected by climate change, yet only a number of scientists understand the impact of climate change on agriculture. Not even agricultural extension agents, who are responsible for disseminating agricultural information to farmers and communities, understand it clearly. Within the uncertainty that climate change brings, the success of farming activities depends on the extension officer's understanding of and effective communication about climate change, since they are the agents of change. This article suggests guidelines for effective communication about climate change by extension agents.

INTRODUCTION

Over the past decades, climate change has emerged as one of the most intensely researched and discussed environmental issues ever around the globe. Many climate change studies and assessments point to more and frequent weather disasters to come, with unprecedented consequences on the global population. However, this information is only known and well understood by a small number of scientists and those that interact with them. While climate change has been discussed broadly in workshops, meetings or at conferences, the question remains whether a significant number of the public is aware of their vulnerability to climate change. So far, it is clear that climate change is likely to have major impacts on farming activities in Namibia, with negative consequences on food security, income generation and livelihoods.

In the light of the above, this article attempts to outline some guidelines for effective communication by extension agents in raising awareness and promoting climate change issues in relation to agricultural activities in Namibia. Therefore, it is vital for the extension agents to have a common understanding of climate change; how to communicate about it and its impact on many sectors of our economy, particularly in agriculture. Only once the agents fully understand climate change and its effects on agricultural activities, will they strive to initiate innovative farming practices which will enhance agricultural productivity and farming income, despite global warming. The scientific evidence leaves little room for doubt that our climate is changing and that agriculture will be affected. Hence communication strategies or awareness programmes around climate change need to be put in place in order to ensure that communities or farmers are kept informed and understand this global issue. This will allow them to adopt better adaptation and mitigation mechanisms to cope with the uncertainties of a changing climate.

COMMUNICATING CLIMATE CHANGE ISSUES

The measurable increase in average global temperatures, termed "global warming" is linked to increases in "greenhouse" gases in the earth's atmosphere (Justus & Fletcher, 2006). When communicating about global warming, the key issues that need to be understood are climate change and climate variability, as well as two complementary issues, namely adaptation and mitigation. When defining climate change one has to understand the difference between weather and climate first. Weather is the current state of the atmosphere on a day-to-day basis for a given area or region, (IPCC and WMO, 2010). Climate, on the other hand, is the average weather of the area over a long period of time; at least over 30 years (IPCC, 2007 & IPCC and WMO, 2010).

Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity (this is called anthropogenic climate change) (IPCC, 2007). Also, it refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer) (IPCC and WMO, 2010). In simplified terms, it refers to any long-term significant change in the average weather that a given area experiences. Most scientists believe that climate change is caused by human activities which include the burning of fossil fuels (coal, oil, and natural gas), driving cars, generating electricity, factories, deforestation, or waste disposal. Historically the wealthy countries have been the biggest contributors to greenhouse gas emissions.

Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events (IPCC and WMO, 2010). Variability may be due to natural internal processes within the climate system (internal variability),