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THE EFFECT OF CONTINUOUS AND ROTATIONAL GRAZING OF SOURVELD ON THE SELECTION OF PLANT FRACTIONS BY SIMMENTALER HEIFERS

DIE INVLOED VAN DIE AANHOUDENDE- EN WISSELBEWEIDING VAN SUURVELD OP DIE SELEKSIE VAN PLANTFRAKSIES DEUR SIMMENTALER VERSE

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ABSTRACT

In a grazing trial conducted at the Kokstad Agricultural Research Station, the selection of six plant fractions by cattle grazing sourveld was investigated. Relations between the selectivity of the cattle and the dry matter digestibility (DMD) and crude protein (CP) content of these fractions were examined. The effects of continuous and six-paddock rotational grazing (each at 1,0 and 2,3 animals/ha) on selectivity were examined.

In general, cattle preferentially selected the glabrous foliar components, which constituted 31,3 % of herbage on offer and had the highest DMD (56 %) and CP content (5,77 %) of the grass fractions. With the exception of broad hairy leaves, rejection of the other components appeared to be primarily related to their lower nutritive value.

Rotational grazing *per se* did not significantly decrease selectivity. In the heavily stocked, rotational grazing treatment cattle consumed a greater proportion of the stem fraction but rejected more of the hairy leaves than in the other treatments. It was thus concluded that cattle continued to graze selectively regardless of the grazing method or the stocking intensity.

UITTREKSEL

'n Weidings-eksperiment is te Kokstad Landbou Navorsingstasie uitgevoer om die seleksie van ses plantfraksies deur beeste wat die Hoë-land Suurveld bewei, te ondersoek. Die verwantskappe tussen die selektiwiteit van die beeste, die droë materiaal verteerbaarheid (DMV) en die ru-proteïn (RP) inhoud van die plantfraksies is ondersoek. Die invloed van aanhoudende- en ses-kamp wisselweiding (elk teen 1,0 en 2,3 diere/ha) op selektiwiteit is ondersoek.

Beeste het oor die algemeen by voorkeur die onbehaarde blaar-dele geselekteer, wat 31,3 % van die beskikbare voer uitgemaak het en wat die hoogste DMV (56 %) en RP-inhoud (5,77 %) van die grasfraksie gehad het. Met die uitsondering van breë behaarde blare, is die verwerping van die ander komponente blykbaar verwant aan hul laer voedingswaarde.

Wisselweiding per se *het nie selektiwiteit betekenisvol verlaag nie. In die hoë belading wisselweiding behandeling het die beeste in groter deel van die stingelfraksie ingeneem maar meer van die behaarde blare verwerp as in die ander behandelings. Daar word dus afgelei dat beeste selektief wei ongeag die beweiding stelsel of die beweidingsintensiteit wat toegepas word.*

Additional index words: Stocking rate, oesophageal fistula, leaf fraction, stem fraction, dry matter digestibility, protein

INTRODUCTION

In a previous paper Kreuter and Tainton (in press) pointed out that claims made in the past about the potential advantages of controlled grazing management in improving short-term animal production have not been realized in tropical and subtropical rangelands (Gammon, 1978; Crowder & Chheda, 1982). For example, in a grazing trial conducted at the Kokstad Agricultural Research Station (Bioclimatic subregion 4f — Phillips, 1973), it was found that the growth rates of cattle were substantially greater under continuous grazing than under rotational grazing (Kreuter *et al*, 1984). However, continuous grazing is widely held to be unacceptable because it leads, in the long term, to veld degradation. It seems advisable to examine the reasons for the better performance under continuous than rotational grazing. This may permit modifications to the rotation systems to improve short-term animal performance.

Grazing animals tend to select a diet that is higher in nutritive value than the mean nutritive value of herbage on offer (Ulyatt, 1973; Hodgson, 1982). Such selection is a two phase process involving, firstly, "site selection" and, secondly, "bite selection" of certain preferred plant types and parts within the selected site. In general, the nutrient concentration of preferred young regrowth and of the foliar fractions of plants is greater than that of the stem fractions and more mature herbage (Crowder & Chheda, 1982). Thus rejected sward components are usually of lower nutritive value but other deterrents to grazing, such as toxic substances or excessive hairiness, may also be a cause for rejection of some plants.

One of the main objectives of rotational grazing is to reduce area and species selectivity. However, it has been reported that, in three veld types at the Matopos Research Station, species selectivity was not lower under rotational than continuous grazing (Gammon & Roberts, 1978) and cattle continued to graze selectively in the False Thornveld of the eastern Cape even when swards were subject to severe defoliation (Danckwerts *et al*, 1983).

However, grazing intake, and thus animal performance, is not an expression only of unrestricted species selection but is affected by forage availability. This is a function of both the amount of herbage on offer and the accessibility of the preferred plant types and parts. For example, in a review of 30 studies, it was shown that the mean difference between leaf and stem fractions in the ingesta was 42 %, with only one percent difference in their digestibilities (Minson, 1982). Ease of prehension is probably the main reason for such preference, as leaves are immediately available to grazing animals and, due to the higher fibre content of stems, the energy required to sever stems is greater than that required for foliage.

Thus, despite the reported perpetuation of species selectivity under rotational grazing, there is a varying but progressive decrease in the opportunity for selection of preferred plant parts because, while cattle are present in a paddock, the rate of herbage removal is invariably greater than the rate of herbage growth, unless the stocking rate is very low and the conditions for herbage regrowth are optimal. For example, it was reported that the leaf content in the diet of cattle grazing *Labala purpureus* decreased from 85 % to 17 % during the 14 day period of stay under rotational grazing, while the proportion of leaf in the diet remained higher under continuous grazing (Hendricksen & Minson, 1980).

The purpose of this paper is to present the results of an investigation undertaken to determine whether there were any nutritional differences in various plant fractions in the sourveld at the Kokstad Agricultural Research Station, the general pattern of selection of these plant parts by grazing cattle and the effect of continuous and rotational grazing on this selection pattern.

PROCEDURE

Data collection

Details of the grazing trial from which data were collected for this analysis are presented in a paper by Kreuter and Tainton (in press). Herbage samples were obtained from clippings of herbage on offer and from cattle fitted with an oesophageal fistula.

During the summer (mid-January to mid-February) and autumn (mid-March to Mid-April) sampling periods, a subsample was obtained from each of the herbage samples collected on the first and sixth day respectively of the one-week period of stay in each rotationally grazed paddock and divided into six plant fractions. The fistula samples were initially allowed to drain and sun dry for about half an hour to remove excess moisture before separation.

The sub-samples were thoroughly mixed after which approximately five grams (dry mass) of each sub-sample were divided into six plant components.

The initial sub-division was into grass and non-grass (weeds — W) components. Thereafter the grass fraction was divided into green (live) and brown (dead — D) components. The live grass fractions were further divided into foliar components (leaf blades) and stems (including leaf sheaths — S). Finally, the foliar fraction was sub-divided into broad hairy leaves (BH — mainly *Tristachya leucothrix* and *Alloteropsis semi-alata*), intermediate glabrous leaves (IG — mainly *Themeda triandra* and *Heteropogon contortus*) and narrow wiry leaves (NW — mainly *Elionurus muticus*).

Each of the constituent plant fractions was forcé-draft dried at 50 °C for 48 hours. Thereafter, each was weighed and its proportional composition of the parent sub-sample calculated. The difference between the proportional composition of each plant fraction in the fistula sub-sample and the corresponding clipped sub-sample was also determined. The difference, thus determined, indicates the relative selection (if positive) or rejection (if negative) of these plant fractions by cattle.

The sub-samples were then bulked according to plant fractions and season. The 12 resulting samples were milled to 1 mm particle size after which their dry matter digestibility (DMD) and crude protein (CP) content were determined using the techniques described by Kreuter and Tainton (in press). These analyses were undertaken to determine whether differences in the general quality of the six plant fractions might explain differences in the degree of selection of rejection of these fractions by grazing cattle.

Analysis of data

The data were analysed by the method described previously (Kreuter & Tainton, in press). Initially an overall analysis was conducted, using all the data, to determine whether the proportional compositions of the six plant fractions were, on average, statistically different. Thereafter, analyses were conducted for each plant fraction to determine whether there were any significant treatment effects on the proportion of each fraction in the herbage samples.

RESULTS AND DISCUSSION

Mean quality and proportions of plant fractions in herbage on offer and their selection by cattle

The overall mean DMD and CP of the six plant fractions in herbage clippings collected during the summer and autumn sampling periods, are presented in Figure 1a and Figure 1b respectively.

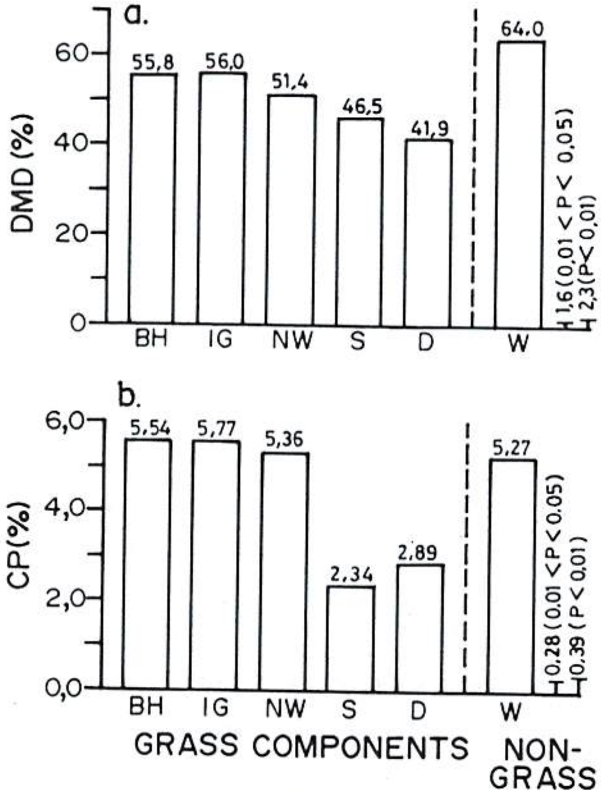

Figure 1 Mean DMD (a) and CP (b) (summer and autumn) of six plant fractions in clipped samples of herbage on offer. (BH = broad hairy; IG = intermediate glabrous; NW = narrow wiry; S = stem; D = dead; W = weed).

Although statistically significant differences in DMD and CP were found to exist between most of the plant fractions ($P < 0,01$) (except the DMD and CP content of the IG compared with those of BH and the CP content of NW compared with that of BH), it is clear from inspection of Figure 1 that the quality of the three foliar fractions was considerably higher than that of the stem (S) and dead grass (D) fractions. This is particularly noticeable in Figure 1b where the mean CP of the stem fraction (2,34 %) was less than half that of the foliar fractions (5,56 %). The weed (W) fraction was, on average, the most digestible component but its CP content was similar to that of the narrow wiry leaves.

Further investigation revealed that there were also between-season differences in the mean nutritive value of the six plant fractions. In all cases where these differences were statistically significant, there was a decrease in the quality of the herbage on offer, from the summer clipping to the autumn clipping, which is in keeping with the characteristics of maturing sourveld. This was particularly evident in the DMD of the three foliar fractions.

Such differences indicate that these six categories can be considered to be discrete in terms of herbage quality, with the exception of broad hairy leaves which are differentiated from intermediate glabrous leaves only by virtue of their hairiness and not by their inherent DMD and/or CP. In terms of the stated objectives of this paper, it is necessary to consider how these differences might account for selection by cattle.

The mean proportional composition of the plant fractions in the herbage on offer (clipped samples) and the mean difference between the fistula and clipped samples are presented in Figure 2a and Figure 2b.

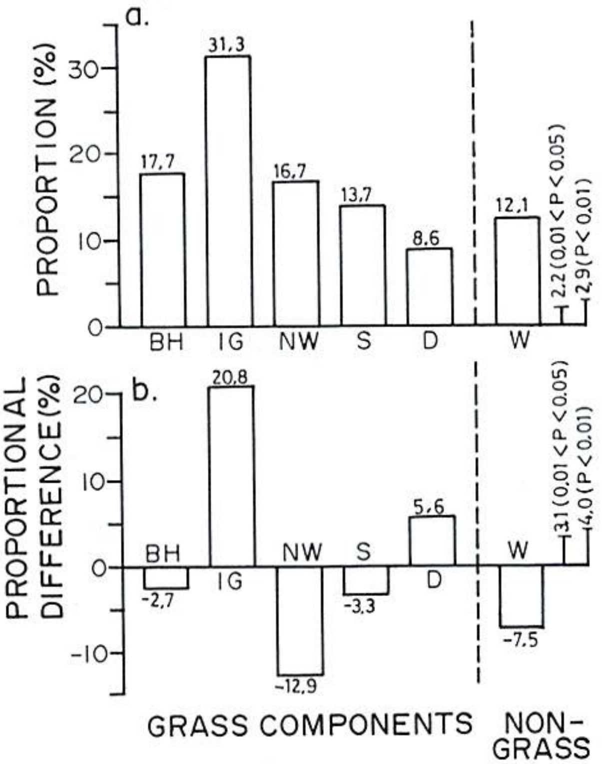

Figure 2 The mean proportion of six plant fractions in clipped samples of herbage on offer (a) and (b) the difference in the mean proportion of these plant fractions in fistula and clipped samples. (BH = broad hairy; IG = intermediate glabrous; NW = narrow wiry; S = stem; D = Dead; W = weed).

The total live grass component (leaves and stems) of the clipped samples, on average, represented 77,7 % of the herbage on offer, more than 80 % of which consisted of the foliar fractions, while the weed and dead grass components constituted the smallest proportions. The proportion of IG was approximately twice that of BH and NW.

Comparison of Figures 1a, 1b and 2b suggests that selection or rejection of a particular plant fraction (relative to the other fractions) may have been related to their DMD or CP content. For example, the IG leaf components, which represented the largest fraction of the herbage on offer and had the highest mean DMD and CF of the grass components, were the most selected components. Similarly, rejection of the stem fraction can be accounted for by the inherently low DMD and CP content of this fraction. The NW leaves were significantly lower ($P < 0{,}01$) in DMD than the IG fraction but higher than the stem fraction. A higher fibre content than in the other foliar fraction may, therefore, have been a deterrent to selection of this component by cattle.

However, it is evident that the pattern of selection or rejection of the plant fractions cannot, in all cases, be explained by differences in the quality of herbage on offer. BH leaves, whose mean DMD and CP content were comparable to those of the IG leaves, were rejected. Hairiness may well have been the major deterrent to selection. In the case of NW leaves, although fibrousness may have been a deterrent to selection, an additional factor may also have been responsible for the rejection of this plant fraction by cattle. A large proportion of this fraction consisted of *Elionurus muticus* leaves which have a bitter taste. Rejection of these leaves may, therefore, have been chemically as well as physically induced. The rejection of the weed component may have been due to its relatively low CP content but, as in the case of the NW leaves, rejection may also have been due to chemical deterrents rather than inherent nutritional quality.

The apparent selection for dead grass components is contrary to expectations based on their inherent low DMD and CP content. This anomaly can probably be attributed to the tendency for the terminal portions of leaves to die off as the leaves mature, so that animals would be forced to ingest this material during grazing.

The effect of grazing management on the proportion of plant fractions consumed by cattle

Due to the small contribution of the dead grass and weed components to the diet selected by cattle, only the foliar and stem fractions of the grass component will be considered here. Furthermore, as treatment differences in the proportion of these plant components in the herbage on offer were found to be small, only the effects of grazing treatment on the relative selection or rejections of these fractions will be presented. These effects are illustrated in Figure 3.

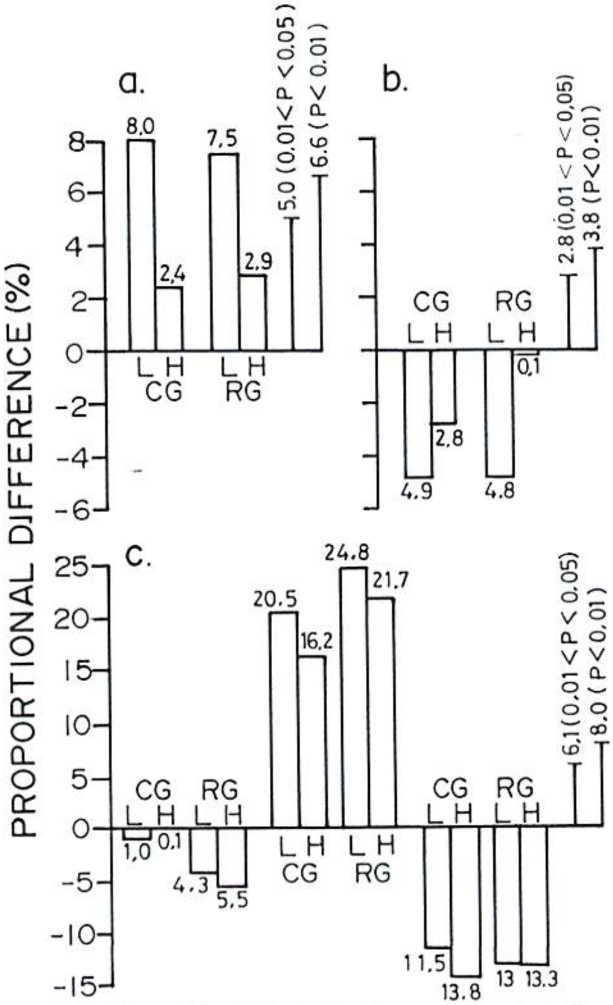

Figure 3 The combined effect of grazing method and stocking rate on the difference of (a) total leaf and (b) stem fractions and (c) broad hairy (BH), intemediate glabrous (IG) and narrow wiry (NW) leaf fractions in fistula and clipped samples (fistula — clipped).
(CG = continuous grazing; RG = rotational grazing; H = high stocking rate; L = low stocking rate).

Although the effects of grazing treatment on the selection of the foliar components and rejection of the stem fractions were not statistically significant, on average, stocking rate was found to suppress selectivity substantially more than grazing method. The only difference between continuous and rotational grazing appears to have been in the opportunity for the cattle to reject the stem fractions at the higher stocking rate under continuous grazing (Figure 2b). Under the high grazing pressure in the rotational grazing, high stocking rate treatment, cattle were apparently forced to graze a larger proportion of the stem fraction of herbage on offer in order to maintain forage intake requirements.

However, comparison of the selection and rejection of the three leaf components (Figure 3c) does not corroborate the contention that opportunity for selection by cattle under different grazing systems is necessarily inversely related to the grazing pressure. Selection of the most preferred IG leaf fraction did decrease as expected with increasing stocking rate. However, selection for this plant component was, on average significantly greater ($0{,}01 < P < 0{,}05$) under rotational than under continuous grazing. Furthermore, rejection of the BH leaves also appears to have been greater under rotational than continuous grazing while there was little difference between the four grazing treatments in the degree of rejection of the NW leaf component.

It therefore appears that, despite the higher grazing pressure applied under rotational grazing, cattle continued to select the preferred plants but consumed a greater proportion of these plants, thereby increasing the intake of the stem fraction in order to maintain their intake requirements. Under such high grazing pressures, regrowth of the heavily defoliated, preferred plants is likely to have had a lower proportion of fibrous stems than more leniently defoliated, less preferred herbage. It is possible, therefore, that, with time, this might result in increasing polarisation in the palatability of the preferred and rejected plant-types. This may explain why the selection for the IG leaf fraction and the rejection of the BH leaf fraction, on average, appeared to be higher under rotational than continuous grazing.

CONCLUSION

From the preceding discussion it is evident that categorization of herbage samples into various plant fractions can be useful in relating animal selection patterns to quality of herbage on offer. However, the fistula samples separation was at times difficult because of the rapid oxidization and thus browning of foliar components.

Some living material may thus have been incorrectly allocated to the dead plant fraction. Rapid freeze drying of samples, before the components are separated out, may be useful in overcoming this problem. Furthermore, in order to reduce experimental error, it woud have been desirable to use larger samples for separation. However, due to the time-consuming nature of the separation technique, this is not always possible.

Cattle were generally found to select the smooth glabrous leafy components (mainly *Themeda triandra* and *Heteropogon contortus*) in favour of the other plant fractions of the herbage on offer. These leaves constituted the largest component of the herbage on offer and of the six plant fractions, they also had the highest DMD (except for weeds) and CP compared with the other five plant fractions. Lower DMD and/or lower CP content may have been resonsible for the rejection of the narrow wiry leaf components, the stem fraction and the weeds.

However, the selective behavior of cattle did not correlate well with the inherent nutritive value (as expressed by DMD and CP content) of the plant fractions of herbage on offer. For example, broad hairy leaves, whose DMD and CP content were almost equivalent to those of the glabrous leaf fraction, were, on average, rejected by the cattle, presumably because of their hairiness. Rejection of the narrow wiry leaves and the weed components may similarly have been due to factors other than nutritive content. In these cases inherent chemical deterrents to selection may have been responsible for rejection by the cattle.

In the comparison of the selective behavior of cattle under continuous and rotational grazing of sourveld at the Kokstad Agricultural Research Station, it was found that rotational grazing *per se* did not appreciably affect selectivity. This conclusion is in accordance with that reached by Danckwerts, *et al* (1983). Only in the rotational grazing, high stocking rate treatment, where stocking intensity was the greatest, were the cattle forced to graze a greater proportion of the stem fraction of herbage on offer than in the other grazing treatments. However, the degree of rejection of the less preferred broad hairy foliar fraction was greater in this treatment than in the other treatments. It appears, therefore, that cattle under pressure will not consume the less preferable plants but that they will consume a greater proportion of the preferred plants in order to maintain dry matter intake. This may explain why no appreciable grazing treatment differences were found in the general quality of the diets selected by the cattle (Kreuter & Tainton, in press).

Animal performance, therefore, appears to be directly related to the availability of the more preferred plant components in the herbage on offer. Unfortunately, accurate estimation of herbage DM on offer and DM intake of animals grazing veld is not easy, particularly under continuous grazing, and it was not possible to obtain reliable estimates in this trial. However, it is apparent that, in trials conducted to account for grazing treatment effects on animal growth rates, such DM estimates need to accompany determinations of the quality of herbage on offer and consumed and the selectivity exhibited by grazing animals, if the intake patterns of cattle subjected to the various grazing treatments are to be understood.

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