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SOME METHODS IN ASSESSING THE EFFECTS OF MIXED GRAZING IN HETEROGENOUS ENVIRONMENTS

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SUMMARY

In extensive range conditions, with a heterogenous vegetation including herbaceous and woody species grazed by a number of animal species, animal preferences for plant species can be defined. This. information can be combined with data on the relative abundance of the plant species using linear programming approaches to help assess the effect of mixed grazing on animal output and preservation of plant species. Limitations are discussed. Three examples suggest that there may be major benef it s in mixed grazing in range conditions.

INTRODUCTION

The aim of the programme of which this work is part is to investigate the role of mixed grazing in preservation of range vegetation and sustaining or improving animal production in the Senegalese Sahel. The objective of the work reported here was to measure preferences of different livestock for individual plant species to assess whether this could lead to a better use of vegetation resources by mixed compared with mono grazing.

METHODS

At the ISRA research centre at Dahra in Senegal six experimental grazing treatments were selected, mono cattle, mixed sheep and goats and mixed cattle, sheep and goats, each at two stocking rates. Animals were stocked in a mob at either a low or high stocking rate and introduced to the six experimental plots for a fixed period each weekday for four weeks according to a latin square type design. The botanical composition of the diet of each animal species was assessed in each experimental grazing period using the 'bergere method' (Guerin et al, 1984). This basic experiment was executed in November/December 1985 (runs 1 and 4) and 1986 and in Spring 1986 (run 3). For each of the six experimental plots detailed vegetation surveys were carried out in early September and November 1985 and in early September, October, November and December 1986. Preferences (DeRancourt et al, 1980) of each animal species for

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each plant species were calculated, using the survey and 'bergere method' data. These express the preference by a grazing species per unit of one pasture fraction relative to a unit of another fraction.

Connolly (1974) showed how linear programming based on a knowledge of differential selection by a number of grazing species for different sward fractions or plant species could be used to get insight into the potential benefits of mixed grazing in rangeland conditions. The method is based on the assumption that the relative preferences of animals for different plant species is constant over mixtures at a particular time. It cannot be applied in its full form here since we do not have information on the total intake for each animal species as well as the total quantity of feed availble in each vegetation category. However, as outlined below, the concepts can be used to give a limited insight into the extent to which differential selection can lead to higher carrying capacity under mixed compared with mono grazing. The high stocking rate dietary data is used as the preferences seemed more stable between mono and mixed grazing there (Nolan et al, 1988). The examples chosen are from runs 1, 3 and 4, with details given for run 1 in Table 1.

Using the patterns of intake for different species as a basis, and taking the intake of individual cattle sheep and goats as 100, 25 and 20 units respectively, Table 1 gives, for run 1, estimated intakes per animal of each of the top eight herbaceous species, the woody species and then a balancing ' species' , to make up for the remaining species. This is the data for the 'All species' case. Total consumption for the mixed grazing treatment where cattle, sheep and goat stocking rates were (1,1.5,2) per 0.54 ha is shown in column 4, obtained by multiplying the first three columns of the table by 1, 1.5 and 2 respectively and summing. We now assume that the preferences as indicated by the consumption patterns are constant for each animal species and that the total of feed consumed for each plant species is the total available, a very narrow assumption. The f ifth, sixth and seventh columns are obtained by dividing the fourth column by the first, second and third columns in turn, and the lowest value in each of them gives the maximum mono species stocking rate that could be sustained subject to the assumptions. For example, in the first run these values for the 'All species' case are 1.40, 2.19 and 2.00 for cattle sheep and goats respectively.

The advantage to mixed grazing is calculated as indicated below. If the cattle, sheep and goat mono grazing maximum stocking rates are denoted by $(C_1,0,0)$, $(0,S_1,0)$ and $(0,0,G_1)$ respectively, then the equation of the plane passing through these three points is

$$1 = \frac{C}{C_1} + \frac{S}{S_1} + \frac{G}{G_1} \qquad (1)$$

The line from the origin to the mixture $(1,1.5,2)$, the actual mixed stocking rate, is given by the equation

$$c = S/1.5 = G/2 \qquad (2)$$

This line intersects the plane (1) at $(k,1.5k,2k)$ where k is

$$k = 1/(1/C_1 + 1.5/S_1 + 2/G_1) \qquad (3)$$

The relative advantage from mixing is estimated as $1/k$, being the ratio of the actual mixed stocking rate achieved $(1,1.5,2)$ to that expected if there were no synergistic effects of mixing, $(k,1.5k,2k)$.

RESULTS AND DISCUSSION

Values of $1/k$ for the three runs for the 'All species' and top five species cases are

Run	1	3	4
Top five species	1.30	1.76	2.60
All species	2.40	2.42	2.63

Thus, in the first run, even with the reduced number of species, the actual mixed stocking rate is 30% higher than that 'expected' assuming no complementary effects. The figures for the benefit of mixing for the other case and the other two runs are very much higher. Mixed grazing, under the assumptions would allow very much greater carrying capacity than mono grazing.

Since the actual mixed grazing stocking rate was 1 cattle beast, 1.5 sheep and 2 goats, the mono grazing limits for sheep and goats are unrealistically low in the 'All species' case. If the analysis is restricted to the top five species, the mono grazing maxima are 1.40, 5.14 and 6.80 (the 6.80 being from the 'balancing species') for cattle, sheep and goats respectively.

These conclusions rest crucially on two assumptions, neither of which can be expected to hold exactly in practice, so the benefit may actually tend to be lower than these figures would suggest. The assumption of stable relative preferences implies that in mono grazing the scarcity of one component of feed will proportionately limit the intake of the other plant species. In reality there may tend to be a greater level of substitution between food sources, with switching as one source becomes scarce and the results above confined to the five main species may be more realistic in that the effects of small components may be unduly distorting the estimation of carrying capacity of sheep and goats in the 'All species' case. The second assumption, that the food actual consumed in the mixture is all that is available is, of course, far too simplistic, assuming a matching of supply to demand that would rarely occur in practice. However, it shows what could occur if feed supply sources were well matched with requirements. In linear programming terms, what has been done by this assumption is to force all the constraints to intersect at a common point, (1,1.5,2). The actual situation with some components in overabundance and with relative preferences not so rigidly defined may reduce this advantage, perhaps by a considerable amount.

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Table 1: Data from Run 1 for a partial linear programming analysis of the impact of differential selection in mixed grazing.

Plant species	Intake per animal			Total	Total intake/ intake per animal		
	Cattle	Sheep	Goats	intake	Cattle	Sheep	Goats
Zornia glochidiata	41.0	5.3	4.2	57.3	1.40	10.91	13.64
Alysicarpus ovalifolius	14.0	3.5	3.4	26.1	1.86	7.44	7.66
Portulaca foliosa	8.0	2.8	1.0	14.1	1.77	5.14	14.13
Corchorus tridens	7.0	1.3	1.8	12.5	1.78	9.98	6.93
Ipomea pestigridis	6.0	2.0	1.4	11.8	1.97	5.90	8.43
Ceratotheca sesamoides	0.0	1.0	1.2	3.9		3.90	3.25
Cassia mimosoides	0.0	1.8	0.6	3.8	-	2.19	6.38
Ipomea vagans	3.0	0.8	0.4	4.9	1.64	6.57	12.31
Woody species	0.0	0.0	2.4	4.8	-	-	2.00
Balance of species	21.0	6.8	3.6	38.3	1.83	5.68	10.65