Fire management in communal rangelands in the Western Province of Zambia

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Key words

Cattle - Rangeland - Burning - Fire - Regrowth - Dry season - Wet season - Farmer - Zambia.

Summary

Cattle farmers were subjected to a questionnaire survey to elucidate their practices and ideas with regard to fires. Eighty percent considered fires beneficial because they provided green grass. However, 15% of the farmers complained about a grass shortage due to burning. A follow-up study monitored the regrowth of grass during the early- to mid-dry season. The dry matter yield three weeks after burning was 0.12 t/ha as opposed to 1.3 t/ha before burning and did not increase further unless re-clipped. The crude protein concentration was higher in regrowth (8.2%) than in unburnt grass (2.8%). Phosphorus levels were influenced more by the site than by burning. Strategic burning of areas with a potential regrowth (loamy soils) is necessary to obtain sufficient quality forage.

■ INTRODUCTION

Annual dry season fires are widespread in the Western Province (WP) of Zambia. Among other reasons, fire is used to provide a green flush for grazing cattle. Whether the use of fire is justified depends on the balance of the advantage of increased quality and the disadvantage of decreased quantity of low quality forage. It can be argued that the sustained use of fire, despite official disapproval, indicates that the users of fire in the WP currently consider the benefits to outweigh the disadvantages (4).

Collaboration on fire management between farmers and extension staff in the WP has been limited, partly due to a lack of technical data. For this reason, a programme was initiated with the aim of developing a policy on fire management. The objectives of the present study were to assess: 1) farmers' perception of fire management; and 2) the regrowth of grass after fire. The second objective resulted from the study on farmers' perception.

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■ MATERIALS AND METHODS

The WP has an area of 122,000 km^2 (5) and is located 22-25°E longitude and 14-17°S latitude (13). The rangelands are communally grazed and management is characterized by low inputs. The average annual precipitation ranges from about 1200 mm in the North to 700 mm in the South (13). The wet season runs from November to April. Precipitation in the 1991/92 wet season preceding the measurements was slightly higher compared to the long term average but with a normal distribution.

Cattle farmers' perception was surveyed by way of an open questionnaire during the dry season of 1991 among 56 cattle owners in four representative high cattle density areas. The distance between the homesteads of each individual participant was at least 15 km.

In two out of these four areas, the regrowth of grass was monitored during the months of June to August 1992, the early- to mid-dry season, after it was burnt in May 1992 by farmers. The period between the last rains and burning was about 10 weeks. One area was the Bulozi flood plain (FP) with sandy to loamy soils where woodlands were absent. The other was the Siloana sand plain comprising: 1) treeless plains (PL) on fine sands dissected by 2) elevated woodlands (WL) on coarse sands.

The most important perennial grass species in FP were *Hyperthelia dissoluta*, *Aristida* spp., *Monocymbium ceresiiforme*

and *Panicum repens*. In PL, *Tristachya nodiglumis* and *T. superba* dominated grasslands were associated with *Aristida congesta*. WL was characterized by *Andropogon brazzae, Eragrostis* spp. and *Digitaria milanjiana* grasses as well as *Terminalia sericea*, *Erythrophleum africanum*, *Burkea africana* and *Guibourtia coleosperma* trees (5).

In each of the three vegetation types, four plots of 3 by 3 meters were fenced. The distance between plots was at least 100 m. Three out of four plots were used to measure regrowth. The fourth one was a control plot in nearby unburnt vegetation, protected with fire breaks, as it would have been burnt later in the dry season. In each plot, four sub-plots of 1 m^2 were established. Sub-plot A was used to measure the height of undisturbed growth, using a calibrated stick of one meter (N = 25 per sub-plot), to check whether the length of grasses could reach 50% of the mature height according to the proposed recommendation for the WP (4). Sub-plot B was clipped 3, 7 and 11 weeks after burning; sub-plot C was clipped 7 weeks after burning; and sub-plot D was clipped 11 weeks after burning. The re-clipping of sub-plot B was undertaken to simulate grazing cattle. The weight of cut grass was measured, and samples were collected and dried for 24 h at 105°C.

The cutting height was 5 cm. Dry matter (DM), nitrogen and phosphorus (P) concentrations were determined. The one-way ANOVA was used to test for statistical differences.

In the months of June and July, grazing behaviour was monitored in five herds of the PL/WL region. All herds were monitored one day per week with a total of 41 observation days. Every 15 min, the activity of five randomly selected animals and the type of forage grazed were recorded, based on Dicko et al. (3). Approximately 50% of the area had been burnt at that time. All herds had a herdsman but cattle were normally left free to roam around.

■ RESULTS AND DISCUSSION

Farmers' perception of fire management

Fires were widespread (table I). They occurred throughout the dry season, but mainly from April to June, shortly after the grass had matured, or from June to August in flooded land. The majority of cattle farmers perceived burning as beneficial because of the regrowth of grass, as also mentioned elsewhere (9, 10, 11). However, they were aware of the shortage of biomass due to the absence of control.

The control of bush encroachment was not mentioned, probably because of the abundance of large plains with relatively low stocking rates (1). There are several additional reasons for the use of fire, such as: clearing of paths between settlements or fields, smoking out bees for honey collection, large game hunting, charcoal production (4, 10), but these were of minor importance to cattle farmers.

Observations on the regrowth of grass

In PL, the height of unburnt grass was 60 ± 11 cm. Three weeks after burning the average height of regrowth was 15 ± 1 cm, while 7 and 11 weeks after burning it was 18 ± 2 cm. In FP, the height of unburnt grass was 75 ± 21 cm. Three weeks after burning the average height of regrowth was 10 ± 3 cm, while 7 and 11 weeks after burning it was 13 ± 4 cm. Therefore, the proposed recommendation (4) not to graze the regrowth until it has reached approximately 50% of the height of unburnt grass cannot be applied. Maybe late-wet instead of early-dry season fires would allow such a regrowth, but the digestibility and crude protein (CP) concentration of DM will decline with increased quantity.

The amount of unburnt grass DM was 1.3 t/ha, whereas that of regrowth was 0.12 t/ha, and remained the same 3, 7 and 11 weeks after burning. The re-clippings of both unburnt and burnt regrowth resulted in lower yields than in plots clipped for the first time at 7 or 11 weeks ($P < 0.05$) (table II). However, the cumulative yields of regrowth in FP and PL of sub-plots B, at 11 weeks, were 275% (0.33 t/ha) and 161% (0.21 t/ha), respectively, of the yields at 3 weeks. Regrowth after clipping of unburnt plots was higher than of burnt plots. At 23 sites spread across different lowlands of the WP, the average regrowth was 0.26 t/ha (1). The higher regrowth rates may have been caused by: wetter depressions compared to the present study, different vegetation and soil types and differences in the period between the last rain and fire. Soil texture appeared to influence the amount of regrowth. WL, which is found on coarse sandy soils, showed no regrowth at all. This was also previously found (1).

The CP concentration of unburnt grass (2.8% of DM) was below maintenance, whereas that of regrowth (8.2% of DM) was above (7% of DM (7)) ($P < 0.001$). The CP levels of regrowth 3, 7 and 11 weeks after burning were the same (table II). No difference in CP concentrations was found between the two regions. A grazing capacity study found 2.9% of DM for the yellow parts, 5.1 for the green parts and 8.3 for regrowth (1). The very low levels of CP in unburnt grass were as expected (11).

There was a difference between the P concentrations of unburnt grass and regrowth of PL ($P < 0.05$) but not of FP ($P = 0.15$). However, there were differences between the regions FP and PL ($P < 0.001$) of both regrowth and unburnt grass. Within regions, the P levels of regrowth 3, 7 and 11 weeks after burning were the same. Jeanes and Baars (5) found P levels of 0.08% of DM for yellow, 0.11% for green unburnt grass and 0.16% for regrowth. The present study, however, revealed an effect per region rather than an effect of burning. All the grasses of FP, whether burnt or not (0.12-0.19% of DM), had more than the level required for maintenance, and all the grasses of PL, whether burnt or not (0.01-0.10% of DM), had P levels below maintenance requirements (0.12%) (6).

Too low a P concentration in the diet affects (re)productive performance (8). The combination of burning and mineral supplementation showed a positive effect on cattle performance (14). This would most likely be the case in the WP also, especially in PL where P levels were far below maintenance. However, calving intervals in PL were shorter than in FP (12).

Grazing behaviour

The cattle were kraaled at night. In FP, they were 7.9 ± 0.3 h outside the kraal, of which 6.0 ± 0.2 h were spent on grazing. In PL, they were 9.0 ± 0.9 h outside the kraal, of which 6.0 ± 0.7 h were spent on grazing. Grazing in the PL/WL region was mainly on regrowth (table III).

Application of results

Farmers perceived burning as beneficial; burning of grass is required to obtain regrowth of a sufficient quality; grazing on regrowth was already considerable in the early- to mid-dry season. Once it is acknowledged that burning is necessary, the next step is to estimate the proportion of the area to be burnt.

Table I

Farmers' perception of fire management in the Western Province of Zambia

	Yes %	No %	Both %
Area is burnt annually	98	2	
Area is entirely burnt annually	94	6	
Burning is beneficial	69	22	9
Burning is always beneficial/bad		12	88
Fires are planned	24	76	
Fires are controlled		100	
Fires can be controlled	82	18	

	%		%
Main advantage of burning:		Main disadvantage of burning:	
- regrowth of grass	80	- shortage of forage	80
- tick control	14	- not related to range management	20
- not related to range management	6		
Why do people burn?		Who starts a fire?	
- regrowth of grass	74	- not known	76
- tick control	13	- other villagers	18
- not related to range management	13	- travelers	3
		- non-cattle owners	3
Who decides when to burn?		Who decides where to burn?	
- anyone	63	- anyone	68
- traditional rulers	26	- traditional rulers	23
- non-cattle owners	11	- non-cattle owners	9
Good burning is defined as:		Bad burning is defined as:	
- applied in correct month	57	- uncontrolled	53
- coordinated	14	- applied in wrong month	35
- vegetation partly burnt	11	- not related to range management	12
- not related to range management	18		
Who is responsible for the control of fires?		Fires are not controlled:	
- people themselves	42	- not known who starts a fire	27
- government	30	- lack of cooperation	23
- traditional rulers	28	- lack of awareness	20
		- government does not assist	14
		- fading away traditions	14
		- difficult to catch culprit	3
Fires can be controlled:		Fires cannot be controlled:	
- if people get organized	53	- lack of cooperation	55
- if government helps	29	- non-cattle owners apply	27
- fire breaks	9	- not known who starts a fire	18
- not known	9		

The following formula calculates the amount of regrowth required to supplement unburnt grass to obtain a maintenance diet of 7% CP in DM:

$$CP_{diet} = X * CP_{burnt} + (1-X) * CP_{unburnt,}$$

or $7 = X * 8.2 + (1-X) * 2.8$, where X = 78%.

Thus 1 kg DM unburnt grass must be supplemented with 78/22 = 3.5 kg DM regrowth. In a grazing capacity study of the WP, calculations were based on a proper use factor of 5% for poor quality unburnt grass and 50% for good quality regrowth (1). In the present study this would mean a DM intake of 0.05 * 1.3 t = 0.065 t/ha and 0.5 * 0.12 t = 0.06 t/ha for unburnt and regrowth grass, respectively. This implies that 0.065/0.06 * 3.5 = 3.8 ha of regrowth is required for each ha of unburnt grass. In other words, approximately 3.8 ha/4.8 ha = 79% of the area must be burnt. This is also suggested by the relative large proportion of time that cattle graze on regrowth (table III). If the diet is assumed to contain 10% browse of 12.5% CP (2), the proportion of burnt area required would be 68%. These results are influenced by soil and vegetation

Table II

DM yields (t/ha), CP and P concentrations (% of DM) (first, second and third block, respectively) of unburnt grass (UB) and regrowth (RE)

Weeks post burning	Bulozi floodplain		Siloana sand plain		Siloana woodland	
	UB	RE	UB	RE	UB	RE
Dry Matter (t/ha DM)						
3	1.0	0.12	0.8	0.13	0.6	0
7	1.8	0.11	1.4	0.11	0.8	0
11	1.4	0.14	1.4	0.11	0.6	0
7 reclip	0.2	0.13	0	0.03	0	0
11 reclip	0.2	0.08	0.2	0.05	0	0
Crude Protein (% of DM)						
3	2.9	10.5	2.6	8.8	3.6	**
7	2.3	7.4	2.9	6.3	3.6	**
11	2.5	8.3	3.8	7.6	3.5	**
7 reclip	2.7	8.5	**	9.7	**	**
11 reclip	5.4	9.0	6.2	10.8	**	**
Phosphorus (% of DM)						
3	0.12	0.19	0.01	0.09	0.01	**
7	0.16	0.17	0.01	0.07	0.01	**
11	0.15	0.16	0.01	0.06	0.01	**
7 reclip	0.16	0.16	**	0.09	**	**
11 reclip	0.12	0.18	0.03	0.10	**	**

** No data due to negligible regrowth

Table III

Type of forage grazed (% of time) in the Siloana sand plain region in the months of June and July 1991

	Woodland	Grassland	Fields	Total
Regrowth	2	34	1	37
Unburnt area	4	25	34	63
Total	6	59	35	100

types, selective grazing, and the number of days between the last rains and fire. But no matter what realistic assumptions are made, the outcome will be that a large proportion of the area must be burnt to allow cattle to graze a diet of sufficient quality. Strategic burning is therefore recommended on good soils in the late-wet or early-dry season, coupled with the planned conservation of standing dry forage.

■ CONCLUSION

Large areas are burnt every year. Farmers perceived the use of fire as beneficial and the observations on the regrowth indicate the need to burn large grazing areas to obtain a good quality diet. This requires a control of fires to some extent which might be very difficult to implement. Strategic burning on soils with a good texture, found in depressions, seems appropriate. Further investigations on the effect of burning and mineral supplementation on cattle performance are required.

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Résumé

Baars R.M.T., Kalokoni D.M., De Koning M.A.I. La gestion du feu dans les pâturages collectifs de la Province de l'Ouest de la Zambie

Une enquête a été réalisée auprès d'éleveurs de bovins afin de comprendre leurs motivations et leur comportement dans la gestion du feu. Quatre-vingt pour cent des personnes interrogées considèrent le brûlage comme bénéfique car il favorise la repousse d'herbe verte. En revanche, 15 p. 100 des fermiers se plaignent qu'il en résulte un appauvrissement des pâturages. Une étude a permis d'évaluer la repousse de l'herbe durant la première moitié de la saison sèche. La production de matière sèche, de 1,3 t/ha avant brûlage, n'atteignait que 0,12 t/ha trois semaines après brûlage, sauf s'il y avait des coupes ultérieures des repousses. La teneur en matières azotées totales était plus élevée dans les repousses après brûlage (8,2 p. 100) que dans le pâturage initial (2,8 p. 100). Les taux de phosphore dépendaient davantage de la situation du pâturage que de l'effet du feu. La stratégie qui consiste à brûler les zones à fort potentiel de croissance (limons) est nécessaire afin d'obtenir un fourrage de qualité satisfaisante.

Mots-clés : Bovin - Parcours - Brûlage - Incendie - Repousse - Saison sèche - Saison humide - Agriculteur - Zambie.

Resumen

Baars R.M.T., Kalokoni D.M. , De Koning M.A.I. El manejo del fuego en pastos comunales en la Provincia de Oeste de Zambia

Con el fin de determinar las prácticas e ideas con respecto al fuego, se llevó a cabo una encuesta entre los ganaderos. Ochenta por ciento consideraron los fuegos beneficiosos, porque proveen pasto verde. Por otro lado, 15% de los finqueros se quejaron de la falta de pasto ocasionada por las quemas. Un estudio de seguimiento registró el crecimiento de pasto durante la estación seca temprana y media. La producción de materia seca después del fuego fue de 0,12 t/ha, contra 1,3 t/ha antes del fuego y sin aumento posterior, excepto en caso de recorte del pasto. La concentración de proteína cruda fue más elevada en la fase de crecimiento después del fuego (8,2%) que en el pasto que no fue quemado (2,8%). Los niveles de fósforo fueron más influenciados por la ubicación que por el fuego en sí. Las quemas estratégicas de zonas con un alto potencial de crecimiento (suelos limosos) es necesaria para obtener suficiente calidad de forraje.

Palabras clave: Ganado bovino - Pastizales - Quema - Incendio - Rebrote - Estación seca - Estación húmeda - Agricultor - Zambia.