The utilisation of maize-crop residues for overwintering livestock 1. Performance of pregnant beef cows as affected by stocking rate

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Received 9 October 1996; accepted 8 December 1997

Over a three-year period (1986 to 1988), non-lactating, pregnant Sussex beef cows were subjected to grazing maize crop residues over the winter feeding period at one of three stocking rates [1.75 (LSR), 3.5 (MSR) or 5.26 (HSR) cows/ha]. Cows were blocked by age, live mass and body condition score (CS). Grazing commenced on 7 July, 9 June and 9 June and ended on 1 September, 1 September and 10 August in the respective seasons. The respective grazing periods were therefore 57, 85 and 63 days. After 8 weeks of grazing, the cows in the LSR, MSR and HSR treatments had gained 23.4, 12.8 and 5.3 kg live mass respectively. Cow CS dropped sharply after 8 weeks grazing, irrespective of stocking rate. Overall, 55.4% of the crop residues remained on the lands at the end of grazing. A higher proportion of grain and leaf (67.2% and 58.7%) was removed from the lands compared to cob and stalk (29.9% and 35.3%).

Oor 'n periode van drie jaar (1986 tot 1988), is nie-lakterende, dragtige Sussex vleisbeeskoeie onderwerp aan die beweiding van mielie-oesreste gedurende die wintervoerperiode teen een van drie veebeladings (1.75 (LVB), 3.5 (MVB) of 5.26 (SVB) koeie/ha). Koeie is geblok volgens ouderdom, lewende massa en kondisietelling (KT). Weiding het op 7 Julie, 9 Junie en 9 Junie begin en is op 1 September, 1 September en 10 Augustus in die onderskeie seisoene gestaak. Dus was die onderskeie weiseisoene 57, 85 en 63 dae lank. Na 8 weke weiding, het die koeie in die LVB, MVB and SVB respektiewelik 23.4, 12.8 en 5.3 kg in lewende massa toegeneem. Koei KT het skerp gedaal na 8 weke van weiding, ongeag die veebelading. In geheel, het 55.4% van die mieliereste op die landerye agterbly aan die einde van die weiperiode. Meer graan en blaar (67.2% en 58.7%) vergeleke met stronk en stam (29.9% en 35.3%) is van die landerye verwyder.

Keywords: live mass gain, body condition score, selective grazing

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Introduction

Overwintering beef cows on maize crop residues is common practice in the maize-producing areas of the Republic of South Africa. It has been calculated that 137 000 ha of maize is sown annually (Agriquest, 1981) in Bioclimatic Groups 6 and 8 of KwaZulu-Natal (Phillips, 1973). Assuming a maize grain yield of 4 t/ha and that for every ton of grain produced, 1 t of crop residue is left on the land (Klopfenstein, 1978), an estimated 548 000 t of residue remains on the lands, potentially a substantial quantity of roughage for winter feeding in these Bioclimatic Groups.

Although little research has been undertaken to investigate the use of maize crop residues in the dry tall grassveld of KwaZulu-Natal (Bioclimatic Group 8; Phillips, 1973), this crop residue has been extensively investigated as a winter feed by a number of researchers in other parts of the

world. In a review article, Ward (1978) concluded that grazing was the most economical means of using crop residues. Based on his survey, Ward (1978) concluded that 0.8 ha residues (5.6 t residues per ha with a grain yield of 3.3 t per ha) was adequate to provide feed for one beef cow for a period of 150 days. In Snyman's (1983) trial, 58 pregnant Simmentaler cows grazed for 42 days on 21 ha of maize crop residues.

Lamm & Ward (1981) examined the changes that take place in the composition of maize crop residues over the grazing period. They found that weathering, caused by the severe winter conditions experienced in that part of the USA where their trial was run, significantly reduced the amount of residues available to livestock when grazed.

The trial was conducted at the Dundee Research Station (altitude 1219 m; latitude 28°10' S; longitude 30°19' E). Winters are dry and the summer rainfall (m.a.p. 777.3 ± 150.6 mm) is low and erratic.

The objective of this investigation was to determine the optimal stocking rate for pregnant beef cows that graze crop residues in the Dundee area of KwaZulu-Natal.

Experimental procedure

Cultivation of the land

Maize was established annually, over a three-year period (1986, 1987 and 1988), at the start of summer on 17 ha of land under dryland conditions. The soil type was classified as an Avalon (MacVicar *et al.*, 1977). The maize was established at a seeding rate of 38 000 plants per ha. Following mechanical reaping, maize cobs remaining on the lands were picked up by hand, which is common practice in northern KwaZulu-Natal.

Treatments

Sixty mature, dry, pregnant Sussex-type cows (mean initial live mass = 461.5 ± 3 kg) grazed the maize residues at one of three stocking rates, namely 1.75 cows/ha (LSR), 3.5 cows/ha (MSR) and 5.26 cows/ha (HSR). The relevant stocking rates were achieved by dividing the 17 ha comprising the trial area into three equal blocks of 5.7 ha and grazing 10, 20 and 30 cows in each block for the LSR, MSR and HSR, respectively. Continuous grazing was applied.

Maize crop residue yield and experimental animals

Prior to the commencement of grazing, the yields of crop residues on the lands were determined in each treatment by collecting and weighing the residues on four areas of 20 m^2. Dry matter content of the residues was determined. After the pasture was grazed, the amount of residues remaining was determined in the same way.

The composition of the crop residues was measured at the same time as the pre- and post-grazing yield estimates. Crop residues from 18 randomly selected areas of 0.09 m^2 per treatment were collected and weighed. The material was divided into cobs (the grain was removed from the cobs and added to the grain fraction), leaves, stalks and maize grain. Each component was individually weighed and the dry matter content determined.

The trial animals were selected randomly from a Sussex herd comprising between 200 and 220 breeding females. The cows were blocked by age, live mass and body condition score (CS) and randomly allocated to treatments within block.

Lick

The Dundee lick (56.5% salt, 19.4% maize meal, 8.1% dicalcium phosphate, 16,0% urea) was sup-

plied *ad libitum* and intake per cow monitored weekly.

Mass and condition score

Each week, the cows were weighed and their CS determined without prior fasting. Body CS was determined according to the method described by Van Niekerk & Louw (1990), which is a 5 point scale (1 = very lean to 5 = obese). At the outset, it was decided that grazing would be terminated in a treatment for the season, once the mean cow body CS had fallen bellow 2.5.

Statistical analysis

Final live mass and final body condition score were compared among treatments by analysis of variance and covariance.

Results

Grazing period

Grazing commenced on 7 July 1986, 9 June 1987 and 9 June 1988 and was terminated on 1 September 1986, 1 September 1987 and 10 August 1988 in the first, second and third seasons of the trial, respectively. Thus, the respective grazing periods were 57, 85 and 63 days. A relatively wet season during the first year of the trial prevented the maize grain from drying out quickly, resulting in a reduced number of grazing days. In the 1988 season, grazing was suspended because the average CS of the cows in the HSR treatment had fallen below 2.5. Grazing was suspended during the 1986 and 1987 seasons by the need to start land preparation to establish the maize for the following season.

Maize crop residue and maize grain yield

The maize grain yields were 5.04, 2.20 and 4.80 t per ha for the 1986, 1987 and 1988 seasons respectively, while the crop residue yield varied from 7.4 to 6.9 t/ha (Table 1).

Live mass and condition score

The live mass gain of the cows over the grazing period decreased with increasing stocking rate (Table 1), as did body condition score (Table 2). Mean CS over the whole trial period declined sharply after eight weeks (Figure 2) and it was therefore decided to compare treatments with reference to live mass and CS at 57 days.

Although mean live mass (mean over three seasons) fluctuated over the grazing season, in the LSR treatment cow live mass tended to increase over the whole grazing period (Figure 1). The mean live mass of cows in the MSR increased up to week 4 of grazing, remained static up to week 8, after which live mass declined gradually, whereas the mean live mass in the HSR treatment tended to fluctuate over the whole grazing period circumjacent to the initial live mass.

Mean cow CS (mean over three seasons) increased in the initial part of the grazing season, up to week 7 for the LSR, but showed a gradual decline after week 4 for the MSR and HSR treatments, respectively. For all treatments, CS declined sharply after eight weeks grazing (Figure 2).

Lick intake

As stocking rate increased, the daily lick intake of the cows increased (Table 3; $p < 0.01$).

Table 1 Initial live mass, final live mass and the change in live mass in beef cows grazing maize crop residues at three stocking rates

Year	Grazing days	Maize grain yield (t/ha)	Pre-grazing residue yield (t/ha)	Treatment (cows/ha)	Initial live mass (kg)	Final live mass* (kg)	Live mass gain/loss* (kg)
1986	57	5.04	7.4	1.75	466.8 ± 16.7	494.0 ± 16.7	27.2
				3.50	467.4 ± 9.0	487.9 ± 9.0	20.5
				5.26	467.4 ± 8.9	480.8 ± 8.6	13.4
1987	85	2.20	7.0	1.75	472.2 ± 12.6	506.2 ± 15.5	34.0
				3.50	471.1 ± 9.4	491.6 ± 9.5	20.5
				5.26	474.2 ± 6.9	484.6 ± 6.4	10.4
1988	63	4.80	6.9	1.75	444.7 ± 8.3	453.6 ± 8.2	8.9
				3.50	443.9 ± 7.5	441.2 ± 6.7	–2.7
				5.26	446.2 ± 6.2	438.4 ± 6.5	–7.8
Mean				1.75	461.2 ± 7.6	484.6 ± 8.8[a]	23.4[a]
				3.50	460.8 ± 5.2	473.6 ± 5.7[b]	12.8[b]
				5.26	462.6 ± 4.4	467.9 ± 4.7[c]	5.3[c]

* Final live mass and change in live mass were compared among treatments at 57 days. [a,b,c] — Means in the same block of a column with different superscripts differ significantly ($p \leq 0.01$).

Table 2 Initial body condition score (CS), final CS and the change in CS in beef cows grazing maize crop residues at three stocking rates over a three-year period (1986 to 1988)

Year	Treatment (cows/ha)	Initial CS	Final CS*	CS gain/loss*
1986	1.75	2.7	3.8	1.1
	3.50	2.6	3.4	0.8
	5.26	2.6	3.0	0.4
1987	1.75	3.2	3.7	0.5
	3.50	3.0	3.3	0.3
	5.26	2.9	3.1	0.2
1988	1.75	2.6	2.8	0.2
	3.50	2.5	2.3	–0.2
	5.26	2.6	2.2	–0.4
Average	1.75	2.8	3.4[a]	0.6[a]
	3.50	2.7	3.0[b]	0.3[b]
	5.26	2.7	2.8[c]	0.1[c]

* Final CS and change in CS were compared among treatments at 57 days. [a,b,c] — Means in the same block of a column with different superscripts differ significantly ($p < 0.01$; analysed by analysis of covariance, with initial CS as covariate).

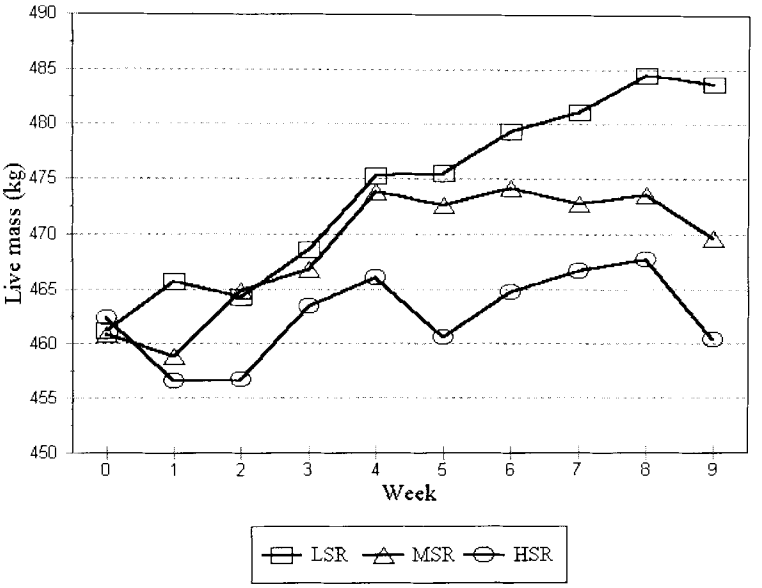

Figure 1 Live mass changes (average over three years) in non-lactating, pregnant beef cows grazing maize crop residues over nine weeks at three stocking rates.

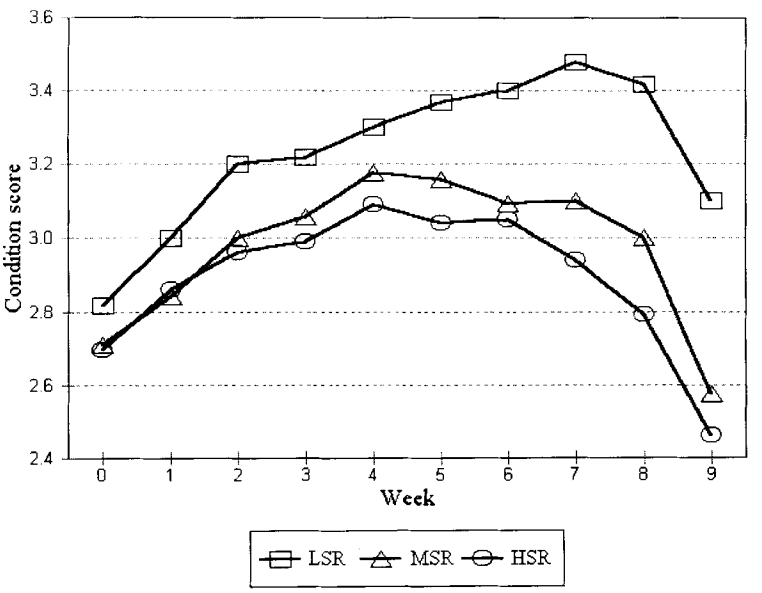

Figure 2 Body condition score (average over three years) changes in non-lactating, pregnant beef cows grazing maize crop residues over nine weeks at three stocking rates.

Utilisation

The utilisation of the crop residues was examined by comparing the composition of the crop resi-

dues before and after grazing had taken place (Table 4; mean over three seasons). Overall, 55.4% of the crop residues remained on the lands at the cessation of grazing, with a relatively high fraction of the grain and leaves (67.2 and 58.7% respectively) compared to cob and stalk (29.9 and 35.3% respectively) being removed. The fractions of the crop residues utilised did not differ significantly among treatments (i.e. stocking rates) or years.

Table 3 Lick intake of dry, pregnant beef cows grazing maize crop residues at a light, medium and heavy stocking rate

	Year			
	1986	1987	1988	Average
Treatment	(g/cow/day)	(g/cow/day)	(g/cow/day)	(g/cow/day)
LSR	179	141	203	174
MSR	241	324	208	258
HSR	234	382	269	295

Table 4 The utilisation of maize crop residues by pregnant beef cows as shown by the composition of the residues, pre- and post-grazing (average over three years)

	Maize crop residue component				
Time sampled	Maize grain (t/ha)	Cob (t/ha)	Leaf (t/ha)	Stalk (t/ha)	Total (t/ha)
Pre-grazing	0.201	1.47	3.17	2.52	7.4
Post-grazing	0.066	1.03	1.31	1.63	4.1
% Utilised	67.2	29.9	58.7	35.3	44.6

Conclusion

Based on live mass gain/ha, it was concluded that the MSR (ie. 3.5 cows/ha) is the optimal stocking rate of pregnant beef cows grazing maize crop residues at Dundee during winter.

Discussion

In view of the number of grazing days achieved in this trial, farmers should not expect more than 60 grazing days from maize crop residues. The decline in live mass and CS toward the end of the grazing period will have to be taken into account if the objective is to retain gains achieved on the residues in preparation for the subsequent breeding season.

Unlike the findings of Klopfenstein (1978), the amount of residues per ha exceeded the maize grain yield per ha and while grain yield fluctuated among years, the yield of maize residues remained relatively constant. The increased lick intake at higher stocking rates are indicative of stress as a result of lower feed availability.

The high proportion of maize grain and leaf material, compared to the cobs and stalks that were removed from the lands, could be a result of selective grazing or because of losses from trampling and weathering. It is of practical significance to note that overall, 55.4% of the crop residues

remained on the lands after grazing. This finding is in agreement with the findings of Lamm & Ward (1981).

Although better animal performance was expected at the lighter stocking rate because of the greater amount of material provided, it is noteworthy that body CS declined rapidly after eight weeks of grazing, irrespective of stocking rate (Figure 2).

Acknowledgements

The authors thank Mrs C.A. Stevens for doing the Biometrical calculations.

References

AGRIQUEST, 1981. Postal survey of agricultural land use. Dept. Agriculture and Fisheries, Natal Region. N 14/1981.

KLOPFENSTEIN, T., 1978. Chemical treatment of crop residues. *J. Anim. Sci.* 46, 841.

LAMM, W.D. & WARD, J.K., 1981. Compositional changes in corn crop residues grazed by gestating beef cows. *J. Anim. Sci.* 52, 954.

MACVICAR, C.M., DE VILLIERS, J.M., LOXTON, R.F., VERSTER, E., LAMPRECHTS, J.J.N., MERRYWEATHER, F.R., LE ROUX, J. & VON HARMSE, H.J., 1977. Grondklassifikasie. 'n Binomiese sisteem vir SuidAfrika. 1 st. ed. Navorsinginstituut vir Grond en Besproeiing. Dept. Landbou-Tegniese Dienste, Pretoria.

PHILLIPS, J., 1973. The Agricultural and Related Development of the Tugela Basin and its Influent Surrounds — A Study in Subtropical Africa. Natal Town and Regional Planning Report Volume 19.

SNYMAN, L.D., 1983. Die gebruik van mielie-oesreste in die voeding van beeste. Vleisbeesoorwinteringskursus, 30 September 1983, Landboukollege, Potchefstroom.

VAN NIEKERK, A. & LOUW, B.P., 1990. Condition scoring of beef cattle. Publication by the Department of Agricultural Development, Directorate Agricultural Information, Republic of South Africa.

WARD, J.K., 1978. Utilization of corn and grain sorghum residues in beef cow forage systems. *J. Anim. Sci.* 46, 831.