

## The performance of lambs on kikuyu as influenced by stocking rate and grazing system

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Stocking rates of 20, 35 and 55 seven-month-old wethers/ha were used to determine the stocking rate/sheep performance relationship on kikuyu under continuous and rotational grazing, considering the stress placed on the animals by decreasing the availability of herbage with higher stocking rates. A total of 100 South African Mutton Merino and 80 Dohne Merino wether lambs were used over a period of three seasons in this study. A multiple regression analysis showed that stocking rate accounted for 58.3% ( $P \leq 0.001$ ), rainfall for 4.1% ( $P \leq 0.001$ ) and grazing system for 0.8% ( $P \leq 0.035$ ) of the variation in ADG. Breed as an independent variable did not contribute significantly to the variation in ADG. The actual ADGs achieved by the wethers were  $84 \pm 3.47$ ,  $53 \pm 4.97$  and  $13 \pm 4.12$  g/day for the lambs in the 20, 35 and 55 stocking rate and continuously grazed treatments while the lambs in the rotational system gained  $80 \pm 5.59$ ,  $40 \pm 5.01$  and  $6 \pm 3.98$  g/day, respectively. In a multiple regression analysis, stocking rate accounted for 1% ( $P \leq 0.041$ ), breed for 13.8% ( $P \leq 0.001$ ) and initial mass for 24.5% ( $P \leq 0.001$ ) of the variation in clean wool growth/day. For variation in fibre diameter, stocking rate accounted for 2.8% ( $P \leq 0.001$ ), initial mass for 18.3% ( $P \leq 0.001$ ), rainfall for 9.3% ( $P \leq 0.001$ ) and breed for 6.6% ( $P \leq 0.001$ ). A quadratic relationship ( $P \leq 0.05$ ) between the mean pre-grazing pasture height and ADG showed that maximum ADG in the rotational grazing system was at a pre-grazing disc-meter height reading of 16 cm. The predicted ADG at a disc-meter height of 16 cm was  $97.8 (\pm 15.28)$  g/day. The quadratic relationship ( $P \leq 0.05$ ) between ADG and post-grazing pasture height showed that the turning point in mass gain was at about a 9-cm pasture height. A significant ( $P \leq 0.05$ ) linear relationship was found in the continuous grazing treatment between pasture height and ADG. The following linear relationships between ADG per animal ( $y$ ) and stocking rate ( $x$ ) were found:  $y = 124.3 - 2.03x$  and  $y = 118.3 - 2.08x$  with  $r$ -values of 0.794 ( $P \leq 0.001$ ) and 0.742 ( $P \leq 0.001$ ) for continuous and rotational grazing, respectively. Maximum gain/ha was achieved (optimum stocking rate) at 31 and 29 wethers/ha producing 1.902 and 1.782 kg/day for continuous and rotational grazing, respectively. The daily livemass gains at these optimum stocking rates were 61.4 and 59.4 g/day, respectively.

Veebeladings van 20, 35 en 55 sewe-maande-oud hamels/ha is gebruik om die veebelading/skaap prestasie verwantskap op kikoejoe weiding onder aanhoudende en wisselweiding te bepaal, in ag genome die spanning wat op diere geplaas is met die vermindering in weiding deur hoër veebeladings. 'n Totaal van 100 Suid-Afrikaanse Vleismerino en 80 Dohne Merino hamel lammers is in die studie oor drie seisoene gebruik. 'n Meervoudige regressie-ontleding het getoon dat veebelading vir 58.3% ( $P \leq 0.001$ ), reënval vir 4.1% ( $P \leq 0.001$ ) en weistelsel vir 0.8% ( $P \leq 0.035$ ) van die variasie in gemiddelde daaglikse massatoename bygedra het. Die werklike GDTs behaal deur die hamels in die aanhoudende beweidingstelsel is  $84 \pm 3.47$ ,  $53 \pm 4.97$  en  $13 \pm 4.12$  g/dag, onderskeidelik, vir die 20, 35 en 55 veebelading. Die lammers in die wisselstelsel het  $80 \pm 5.59$ ,  $40 \pm 5.01$  en  $6 \pm 3.98$  g/dag GDT, onderskeidelik, behaal. In 'n meervoudige regressie-ontleding, het veebelading vir 1% ( $P \leq 0.041$ ), ras vir 13.8% ( $P \leq 0.001$ ) en aanvangsmassa vir 24.5% ( $P \leq 0.001$ ) vir die variasie in skoon wolgroei per dag bygedra. Vir die variasie in veseldeursnee het veebelading vir 2.8% ( $P \leq 0.001$ ), aanvangsmassa vir 18.3% ( $P \leq 0.001$ ), reënval vir 9.3% ( $P \leq 0.001$ ) en ras vir 6.6% ( $P \leq 0.001$ ) bygedra. 'n Kwadratiese verwantskap ( $P \leq 0.05$ ) tussen die gemiddelde hoogte van die weiding voor beweiding en GDT toon dat maksimum massatoename by ongeveer 16 cm voorgekom het. Die voorspelde GDT by 'n skyfmetehoogte van 16 cm is  $96.7 (\pm 15.28)$  g/dag. Die kwadratiese verwantskap ( $P \leq 0.05$ ) tussen massatoename en hoogte van die weiding na beweiding toon 'n draaipunt in GDT by ongeveer 9 cm. 'n Betekenisvolle ( $P \leq 0.05$ ) lineêre verwantskap tussen die hoogte van die weiding en GDT is in die aanhoudende weistelsel gevind. Die volgende lineêre verwantskap tussen GDT per dier ( $y$ ) en veebelading ( $x$ ) is gevind:  $y = 124.3 - 2.03x$  en  $y = 118.3 - 2.08x$  met  $r$  waardes van 0.794 ( $P \leq 0.001$ ) en 0.742 ( $P \leq 0.001$ ) vir aanhoudende en wisselweiding, onderskeidelik. Maksimum massatoename/ha word verkry (optimum veebelading) by 'n veebelading van 31 en 29 hamels/ha met 1.902 en 1.782 kg/dag, onderskeidelik, in aanhoudende en wisselweiding. Die daaglikse massatoename by die optimum veebeladings is 61.4 en 59.4 g/dag, onderskeidelik.

**Keywords:** Average daily gain, final mass, sheep, wool growth.

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### Introduction

Kikuyu (*Pennisetum clandestinum*), under dryland conditions, is the predominant summer pasture in the Natal Midlands and also in other regions of Natal and South Africa. In spite of its importance as a summer grazing species for the higher rainfall regions, relatively little work investigating sheep production on kikuyu has been undertaken in South Africa. While the optimum

stocking rate for sheep on kikuyu have not been determined, stocking rates of 60 to 100 ewes/ha are being recommended in the field.

Stocking rate is known to be one of the most important pasture management factors affecting the performance of animals grazing pastures (Jones & Sandland, 1974; Edwards, 1980), largely as a consequence of its influence on herbage availability and the

subsequent stress on the animal (Bransby, 1983). Rotational grazing on kikuyu, according to Booysen *et al.* (1975), is inferior to continuous grazing over a wide range of stocking rates, and only at relatively high stocking rates does rotational grazing lead to better animal production than continuous grazing. In Natal, little data is available on the response of sheep grazing dryland kikuyu pastures and, in particular, on their response to the important managerial factors of stocking rate and grazing system.

The objective of this study was to determine the stocking rate/sheep performance relationships on kikuyu under either continuous grazing or rotational grazing, taking into account the stress placed on animals by high stocking rates owing to the decreased availability of herbage.

## Experimental procedure

### Experimental terrain

The experiment was undertaken during the summer months of 1989 to 1992 at Cedara (29°32'S; 30°17'E, altitude 1075m) in the Natal Mistbelt. Mean annual rainfall is 885 ± 142 mm, most of which falls during the summer months (October to March). The 1.5-ha dryland kikuyu pasture is grown on a Hutton/Doveton soil form.

### Pasture management and treatments

Stocking rates of 20, 35 and 55 wethers/ha were used. Each of the three stocking rates was grazed under a rotational (Rot) and continuous (Con) grazing system. The kikuyu was grazed and mowed annually during late September to get a pasture of the same height at the start of each trial period for each of the treatments. One application of ammonium sulphate in October and two applications of limestone ammonium nitrate (LAN - 28%) during November and February were applied, resulting in a 250-kg N/ha application rate for the season. The areas used for rotational grazing were subdivided into eight paddocks. In the rotational grazing system a fixed period of stay of 3.5 days per paddock was applied, followed by a 24.5-day period for regrowth. The treatments were allocated to the same area annually.

### Experimental animals

For Trials 1, 2 and 3 (1989/90, 90/91 and 91/92 seasons), a total of 100 South African Mutton Merino (SAMM) and 80 Dohne Merino wether lambs with an initial mass of 33.3 ± 2.88 kg for the three trials were used. The wethers were balanced between the six treatments according to live mass and breed, within season, in a randomized block design. However, initial mass varied for the different seasons. The grazing periods were 196, 175 and 182 days for Trials 1–3, respectively.

The wethers were weighed every Monday, water and feed not being withheld prior to the weighing, except for the last weighing at the end of the trial when the animals were starved for about 18 hours. The lambs were graded on the hoof by an experienced stockman at the end of each trial. The lambs had free access to fresh water and a mineral lick, which consisted of 50% salt, 25% bonemeal and 25% feedlime. The sheep were dosed and inoculated according to a local management programme. Worm egg counts were conducted on a weekly basis by Allerton Veterinary Laboratories and the results were also used as a guide for dosing.

The lambs were shorn before and after the trials to give a 208, 245 and 260-day wool growth for Trials 1–3, respectively. The

wool growth and the grazing period differ because the lambs were shorn during September and kept in the same conditions until the start of the experiment in early November. A midrib wool sample was taken from each fleece and analysed at the SA Fleece Testing Centre at Grootfontein for fibre diameter and clean yield, using the standard method proposed by the International Wool and Textile Organisation.

### Pasture availability

Pasture availability and the severity of grazing were measured with a pasture disc meter (Bransby & Tainton, 1977), expressed in cm. In the rotational grazing system, 25 disc-meter readings before and after grazing were taken in all eight paddocks. The average of these values per grazing cycle and for the trial period were calculated. On the continuously grazed camps, 50 disc-meter readings were taken once a week and the average of these values per cycle (according to rotational grazing cycles) and for the trial were calculated. The mean disc-meter heights were used to describe the relationship between average daily gain (ADG) and the pre- and post-grazing pasture heights. The following equation, derived under local conditions and given by Bartholomew (1985), was used to determine pasture dry matter yield:

$$y = 749.5 + 242.79 (\pm 10.37)d$$

where

$$y = \text{yield in kg dry matter/ha}$$

$$d = \text{mean pasture disc-meter height (cm)}$$

### Chemical analysis

Hand-cut herbage samples, cut to ground level, were randomly collected every 3.5 days in the rotational grazing, and weekly in the continuous grazing treatments. Crude protein (CP) (macro-Kjeldahl N), dry matter and ash (AOAC, 1980), acid detergent fibre (ADF) and neutral detergent fibre (NDF) analyses (Goering & Van Soest, 1970 with modifications as reported by Van Soest & Robertson, 1980) were determined.

### Statistical analysis

The data were analysed over two periods, the first 140 days and the total trial period of 184 ± 11 days. Multiple regression (Genstat statistical program, Lawes Agricultural Trust, Rothamstead Experimental Station, 1987) analyses were performed for the variables final mass, ADG, wool growth (g/day) and fibre diameter using the predictor variables stocking rate, initial live mass, breed, days on pasture, disc-meter heights, rainfall and temperature of each season. Analyses of variance were performed, using Statgraphics (1988), on wool growth per day and fibre diameter to test for significance of treatments. Regression equations were fitted for ADG and pre- and post-grazing disc-meter heights by using the simple regression procedure of Statgraphics (1988).

## Results and Discussion

### Seasonal conditions

The average rainfall and temperature for the trial period compare favourably with the long-term rainfall and temperature data for the area.

### Chemical composition

It is noticeable that there is no difference in the chemical composition between the stocking rates and the two grazing systems (Table 1). The relatively small standard deviation obtained from the different chemical fractions indicates that the quality of kikuyu did not change during the growing season when analysed at the same stage of regrowth. It was found by Colman & Holder (1968) and Aii & Stobbs (1980) that kikuyu protein levels remain high throughout growth and at maturity.

The CP (Table 1) content compares well with values found by Cross (1979). The ADF and ash values found in this study compare well with those measured by Joyce (1974).

**Table 1** The average chemical composition (% DM) of hand-clipped kikuyu samples for the period November to April during three seasons (1989/90, 1990/91 and 1991/92)

Component	Stocking rate (wethers/ha)						Mean
	20		35		55		
	Con	Rot	Con	Rot	Con	Rot	
Crude protein	18.3	18.4	18.1	19.0	18.7	20.3	18.8
	±0.616	±0.624	±0.561	±0.527	±0.496	±0.725	±0.244
Ash	11.2	11.7	11.4	11.4	10.9	12.00	11.4
	±0.366	±0.360	±0.234	±0.243	±0.311	±0.411	±0.133
ADF	33.4	32.0	33.3	32.4	34.3	32.2	33.0
	±0.541	±0.782	±0.601	±0.855	±0.886	±0.767	±0.308
NDF	74.1	73.7	73.7	73.1	75.1	72.8	73.7
	±1.132	±1.075	±0.984	±1.067	±1.174	±0.978	±0.437

### Final mass

A stepwise multiple regression analysis was used to identify the factors responsible for the variation in the final mass of the wethers. In Table 2, it is clear that the stocking rate accounted for 36.7% ( $P \leq 0.001$ ), initial mass for 34.5% ( $P \leq 0.001$ ), rainfall for 2.4% ( $P \leq 0.001$ ) and grazing system for 0.6% ( $P \leq 0.034$ ) of the variation in the final mass at the end of the trial. The regression equation describing the final mass is given in Table 2.

The difference in herbage availability, i.e. the effect of different stocking rates, is clearly demonstrated in the final mass of the

lambs. The actual average final mass of the wethers decreased from  $49.0 \pm 1.05$  kg in the 20 Con Treatment to  $34.5 \pm 1.34$  kg in the 55 Rot Treatment. When stocked at 20 and 55 lambs/ha, respectively, the regression equation in Table 2 predicts a final mass of 45.2 and 32.0 kg for lambs with an initial livemass of 30 kg, under continuous grazing and a rainfall of 850 mm for the season.

### Average daily gain

#### ADG for the first 140 days

Stocking rate accounted for 37.4%, rainfall for 11.2% and a stocking rate/grazing system interaction for 5.5% of the variation in the average daily gain of the wethers for the period November to about April (Table 3).

The actual ADG of the wethers measured during the first 140 days of grazing was  $99 \pm 4.00$ ,  $76 \pm 6.55$  and  $46 \pm 5.84$  g/day for the 20 Con, 35 Con and 55 Con Treatments and  $90 \pm 6.10$ ,  $53 \pm 5.40$  and  $22 \pm 6.01$  g/day for the 20 Rot, 35 Rot and 55 Rot Treatments, respectively.

#### ADG of the total experimental period

In a stepwise multiple regression analysis, stocking rate accounted for 58.3%, rainfall for 4.1% and grazing systems for 0.8% of the variation in ADG achieved for the total grazing period (Table 4).

Breed as an independent variable did not play a significant role in the variation in ADG. The actual ADGs achieved by the wethers over the total period were  $84 \pm 3.47$ ,  $53 \pm 4.97$  and  $13 \pm 4.12$  g/day for the 20 Con, 35 Con and 55 Con Treatments and  $80 \pm 5.59$ ,  $40 \pm 5.01$  and  $6 \pm 3.98$  g/day for the 20 Rot, 35 Rot and 55 Rot Treatments, respectively. The contribution of stocking rate to ADG for the 184 days is 58.3% ( $P \leq 0.001$ ) compared with the 37.4% ( $P \leq 0.001$ ) for the first 140 days of the trial. The difference in contribution might be explained by the observation that the availability of herbage became a major problem during April and the first week of May in the last 40 days of the trial.

The data from this study show clearly that the grazing system made a significant contribution to final mass ( $P \leq 0.034$ ) and to ADG over the total grazing period ( $P \leq 0.035$ ) with continuous grazing being a better system concerning animal performance when compared with rotational grazing at all three stocking rates varying from 20 to 55 lambs/ha. According to Booyesen *et al.*

**Table 2** Predicting the final mass (kg) of wethers grazing kikuyu during three seasons (Trials 1 – 3) at three stocking rates and two grazing systems

Dependent variable	Independent variable(s)	Contribution of independent variables ( $R^2$ )	Significance of added independent variable
$Y = \text{Final mass}$	Stocking rate ( $X_1$ )	36.7	$P \leq 0.001$
	SR ( $X_1$ ) + Initial mass ( $X_2$ )	71.2	$P \leq 0.001$
	SR ( $X_1$ ) + IM ( $X_2$ ) + Rainfall ( $X_3$ )	73.6	$P \leq 0.001$
	SR ( $X_1$ ) + IM ( $X_2$ ) + Rainfall ( $X_3$ ) + Grazing system ( $X_4$ )	74.2	$P \leq 0.034$

Regression equation:

$$Y = 9.30 (\pm 4.97) - 0.377 (\pm 0.0235) X_1 + 0.9569 (\pm 0.0624) X_2 + 0.0173 (\pm 0.0044) X_3 - 1.419 (\pm 0.663) X_4$$

Sy.x = 4.277

SR: Stocking rate

IM: Initial mass

Grazing system: Rotational grazing = 1; Continuous grazing = 0

Rainfall: 710.8 – 980 mm

**Table 3** Predicting the average daily gain (g) of lambs on kikuyu for 140 days at three stocking rates and two grazing systems

Dependent variable	Independent variable(s)	Contribution of independent variables ( $R^2$ )	Significance of added independent variable
Y = Average daily gain	Stocking rate ( $X_1$ )	37.4	$P \leq 0.001$
	SR ( $X_1$ ) + Rainfall ( $X_2$ )	48.6	$P \leq 0.001$
	SR ( $X_1$ ) + Rainfall ( $X_2$ ) + SR.Grazing system ( $X_3$ )	54.1	$P \leq 0.001$

Regression equation:

$$Y = -14.5 (\pm 23.4) - 1.492 (\pm 0.153) X_1 + 0.1623 (\pm 0.0259) X_2 - 0.476 (\pm 0.105) X_3$$

$$S_{y.x} = 26.52$$

SR: Stocking rate

GS: Grazing system (Rotational grazing = 1; Continuous grazing = 0)

Rainfall: 710.8 – 980 mm

**Table 4** Predicting the average daily gain (g) of wether lambs over the total grazing period at three stocking rates and two grazing systems over 3 seasons on kikuyu

Dependent variable	Independent variable (s)	Contribution of independent variables ( $R^2$ )	Significance of added independent variable
Y = Average daily gain	Stocking rate ( $X_1$ )	58.3	$P \leq 0.001$
	SR ( $X_1$ ) + Rainfall ( $X_2$ )	62.4	$P \leq 0.001$
	SR ( $X_1$ ) + Rainfall ( $X_2$ ) + Grazing system ( $X_3$ )	63.2	$P \leq 0.035$

Regression equation:

$$Y = 39.8 (\pm 20.4) - 2.057 (\pm 0.126) X_1 + 0.0974 (\pm 0.0225) X_2 - 7.57 (\pm 3.57) X_3$$

$$S_{y.x} = 23.02$$

SR: Stocking rate

Rainfall: 710.8 - 980 mm

Grazing system: Rotational grazing = 1; Continuous grazing = 0

(1975), kikuyu grazed leniently before animals are moved to the next enclosure remains inferior to kikuyu grazed continuously over a wide range of stocking rates. Only at very high stocking rates is rotational grazing superior to continuous grazing. This is due to the benefit of intermittent rest on growth rate. According to Booysen *et al.* (1975), the relationship between livemass gain per animal per day (ADG) or per ha and the stocking rate should be established in a wide range of environments and for all the potentially economic pasture species. The performance achieved by the lambs in the 55 lambs/ha stocking rate clearly showed that higher stocking rates will not be of any advantage to young animals.

#### Grades achieved by lambs

A multiple regression analysis showed that stocking rate accounted for 44.4% ( $P \leq 0.001$ ) and initial mass for 12.8% ( $P \leq 0.001$ ) of the variation in the grades. It was found that 85 to 92% of the Dohne Merino wethers and approximately 95% of the SAMM wethers graded A2 and fatter in the low stocking rate, while 92 – 100% of the Dohne Merino and 67.9 – 79% of the SAMM wethers graded A0 and A1 in the high stocking rate. It is therefore possible to produce marketable lambs in about 184 days off kikuyu at a low to medium stocking rate. The significant contribution ( $P \leq 0.001$ ) of initial mass to the variation in grades showed that heavier lambs, when put to graze on kikuyu, achieved better grades at the end of the grazing period.

#### Wool growth

In a stepwise regression analysis, stocking rate accounted for 1%, breed for 13.8% and initial mass for 24.5% of the variation in clean wool growth per day (Table 5). Stocking rate accounted for 2.8%, initial mass for 18.3%, rainfall for 9.3% and breed for 6.6% of the variation in fibre diameter (Table 5). It is interesting to note that rainfall correlated negatively with the fibre diameter of the wool. The actual wool growth per day and fibre diameter data of the Dohne Merino and the SAMM wethers are summarized in Table 6.

#### Pasture availability and animal pasture relationships

The following quadratic relationships were found in the rotational grazing treatments between the mean pre-grazing pasture heights ( $x$ ) and ADG ( $y$ ) for the first 140 days and the total grazing period, respectively:

$$y = -1869.66 + 242.63 (\pm 89.917)x - 7.483 (\pm 2.947)x^2$$

$$(S_{y.x} = 15.238, R^2 = 0.789, P \leq 0.05)$$

and

$$y = -1254.76 + 169.58 (\pm 64.102)x - 5.378 (\pm 2.199)x^2$$

$$(S_{y.x} = 14.937, R^2 = 0.772, P \leq 0.05).$$

For both the 140 days and the total grazing period, the turning point in ADG for rotational grazing is at a pre-grazing disc-meter height reading of approximately 16 cm and pasture yield of 4634 kg DM/ha. The predicted ADG at a disc-meter height of 16 cm is 96.8 and 81.8 g/day for the first 140 days and for the total period,

**Table 5** Predicting the clean wool growth (g/day) and fibre diameter of wethers grazing kikuyu at three stocking rates and two grazing systems for three seasons

Dependent variable	Independent variable(s)	Contributions of independent variables ( $R^2$ )	Significance of added independent variable
$Y =$ Wool growth	Stocking rate ( $X_1$ )	1.0	$P \leq 0.041$
	SR ( $X_1$ ) + Breed ( $X_2$ )	14.8	$P \leq 0.001$
	SR ( $X_1$ ) + Breed ( $X_2$ ) + Initial mass ( $X_3$ )	39.3	$P \leq 0.001$
$Y =$ Fibre diameter ( $\mu$ )	SR ( $X_1$ )	2.8	$P \leq 0.001$
	SR ( $X_1$ ) + IM ( $X_2$ )	21.1	$P \leq 0.001$
	SR ( $X_1$ ) + IM ( $X_2$ ) + Rainfall ( $X_3$ )	30.4	$P \leq 0.001$
	SR ( $X_1$ ) + IM ( $X_2$ ) + Rainfall ( $X_3$ ) + Breed ( $X_4$ )	37.0	$P \leq 0.001$

Regression equation for wool growth:

$$Y = -0.996 (\pm 0.945) - 0.019 (\pm 0.009) X_1 + 2.312 (\pm 0.277) X_2 + 0.202 (\pm 0.025) X_3$$

$$S_{y.x} = 1.686$$

Regression equation for fibre diameter:

$$Y = 26.89 (\pm 1.60) - 0.0233 (\pm 0.0071) X_1 + 0.0681 (\pm 0.0201) X_2 - 0.0074 (\pm 0.0014) X_3 - 0.894 (\pm 0.213) X_4$$

$$S_{y.x} = 1.288$$

SR: Stocking rate

IM: Initial mass

Breed: Dohne Merino = 1; SAMM = 0

**Table 6** The average ( $\pm$  SE) wool growth (g/day) and fibre diameter ( $\mu$ ) of Dohne Merino and SAMM wethers grazing kikuyu at three stocking rates and two grazing systems

	Stocking rate (wethers/ha)					
	20		35		55	
	Con	Rot	Con	Rot	Con	Rot
<b>Dohne Merino:</b>						
Clean wool/day (g)	8.03 <sup>a</sup>	7.13 <sup>a,b</sup>	6.72 <sup>a,b</sup>	7.39 <sup>a,b</sup>	6.38 <sup>a,b</sup>	6.06 <sup>b</sup>
	$\pm 0.706$	$\pm 0.381$	$\pm 0.828$	$\pm 0.387$	$\pm 0.387$	$\pm 0.442$
Fibre diameter ( $\mu$ )	21.1 <sup>a,b</sup>	21.9 <sup>a</sup>	20.2 <sup>b</sup>	20.9 <sup>a,b</sup>	20.3 <sup>b</sup>	20.4 <sup>b</sup>
	$\pm 0.41$	$\pm 0.43$	$\pm 0.36$	$\pm 0.49$	$\pm 0.24$	$\pm 0.29$
<b>SA Mutton Merino:</b>						
Clean wool/day (g)	6.17	5.90	6.11	5.00	5.43	5.70
	$\pm 0.399$	$\pm 0.402$	$\pm 0.351$	$\pm 0.377$	$\pm 0.380$	$\pm 0.444$
Fibre diameter ( $\mu$ )	22.5 <sup>a,b</sup>	22.7 <sup>a</sup>	22.1 <sup>a,b,c</sup>	21.4 <sup>c</sup>	21.6 <sup>c</sup>	21.6 <sup>c</sup>
	$\pm 0.32$	$\pm 0.36$	$\pm 0.32$	$\pm 0.41$	$\pm 0.31$	$\pm 0.27$

<sup>a-c</sup> Values in the same row with different superscripts are significantly ( $P \leq 0.05$ ) different

respectively. Reid (1986) found that lambs had a growth rate of 89 g/day on a herbage allowance of 6 kg DM/ha/day compared with 33.4 g/day for lambs offered 2 kg DM/ha/day on kikuyu. The relationship between ADG ( $y$ ) and post-grazing pasture height ( $x$ ) for the total period is described by the following quadratic equation:

$$y = -441.38 + 119.42 (\pm 73.278)x - 6.890 (\pm 5.252)x^2$$

$$(S_{y.x} = 16.930; R^2 = 0.707, P \leq 0.05).$$

The relationship shows that the turning point in ADG is at about a 9-cm pasture height and a pasture yield of 2 934 kg DM/ha. Hughes *et al.* (1988) found that cows grazing long kikuyu (1 200 kg of dry green leaf) produced an extra 1.6 kg milk/cow/day, and that the protein concentration of their milk was 0.14 units higher

than that of cows on short (800 kg/ha of dry green leaf) kikuyu. According to Henning (1993), kikuyu pastures should be grazed when they reach a canopy of 15 – 18 cm. For milk production, the pasture should be grazed down to a canopy height of 8 – 10 cm. With dry stock, the pasture could be grazed down to 6 cm. On Italian ryegrass, the ADG of pre-weaned lambs reached a maximum at a post-grazing height of approximately 6 cm (De Villiers *et al.*, 1993), probably because of the difference in pasture management between tropical and temperate pastures.

The following linear relationships were found to be sufficient for the continuous grazing treatment between pasture height ( $x$ ) and ADG ( $y$ ) for the first 140 days and the total grazing period:

$$y = -99.329 + 14.726 (\pm 3.316)x$$

$$(S_{y.x} = 17.64, R^2 = 0.700, P \leq 0.05)$$

and

$$y = -107.38 + 13.939 (\pm 3.308)x$$

( $Sy.x$  18.79,  $R^2 = 0.677$ ,  $P \leq 0.05$ ).

The linear relationship for the continuous grazing system clearly indicates the positive relationship between pasture availability and animal performance.

The better performance of the lambs at the low and medium stocking rates is possibly because of an abundance of acceptable fodder available and because they are selective in their grazing. Bransby (1981) found that in terms of quality, kikuyu appears to be less sensitive to management, the difference between continuous and rotational grazing being mainly one of pasture availability. Minson (1981) stated that, when the quantity of leaf is low, animals grazing tropical species prefer to restrict intake rather than to increase the quantity of stem in their diet. Davison *et al.* (1985a; 1985b) found that the leaf content of a panic (*Panicum maximum* cv. Gatton) diet was substantially reduced under high stocking rate, low pasture availability and reported a close correlation between milk production and leaf yield. Wright & Russel (1987) showed that a shorter plant height decreased intake rate, while Seman *et al.* (1991) found that with steers, animal gain and intake are more sensitive to forage height than density.

#### Relationship between stocking rate and animal performance

The relationship between stocking rate and ADG and between stocking rate and gain/ha/day, determined for the total experimental period, is illustrated in Figure 1. The data from the present trial confirm the linear relationship between stocking rate and animal performance found by Jones & Sandland (1974). Furthermore, the data indicate the dependence of animal performance on pasture availability. In accordance with the Jones & Sandland (1974) model, the stocking rate ( $x$ ) : average daily gain/animal ( $y$ ) relationship took the form  $y = a - bx$  for continuous and rotational grazing (Figure 1). The equations are:

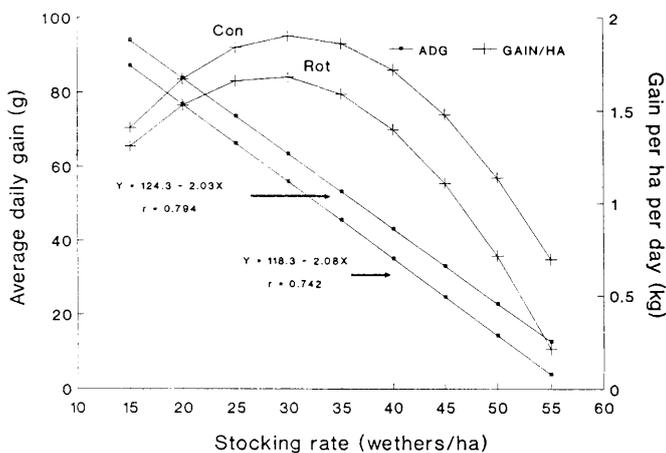
$$y = 124.3 - 2.03 (\pm 0.169)x$$

( $Sy.x$  = 22.39)

and

$$y = 118.3 - 2.08 (\pm 0.209)x$$

( $Sy.x$  = 26.13)



**Figure 1** The relationship between stocking rate and average daily gain per animal, and between stocking rate and livemass gain/ha/day for wethers grazing kikuyu for three seasons.

with  $r$  values of 0.794 ( $P \leq 0.001$ ) and 0.742 ( $P \leq 0.001$ ) for continuous and rotational grazing, respectively. Gain/ha/day ( $z$ ) was calculated by means of the equation  $z = ax - bx^2$  using the 'a' and 'b' values from the corresponding linear equation described above. Analysis of the data show that  $SR_{max}$  for continuous grazing can be expected at 31 wethers/ha and for rotational grazing at 29 wethers/ha, which is essentially the same in practice. At  $SR_{max}$  under continuous grazing, the ADG of the wethers would be 61.4 g/day with a daily gain/ha of 1.902 kg/day, and, in a rotational grazing system the ADG would be 59.4 g/day with a daily gain/ha of 1.782 kg/day. From Figure 1 it can be seen that the grazier must be clear on whether he wishes to maximize production per animal or per ha, as each requires a different stocking rate.

#### Conclusion

There were no apparent differences in the chemical composition of the kikuyu between the different treatments, and the conclusion can thus be made that stocking rate, as shown by the multiple regression analysis, affected animal performance through its influence on herbage availability. The reason for the better performance shown by the wether lambs in the low stocking rates and continuous grazing system is possibly that there was an abundance of acceptable fodder available and animals were selective when grazing. One therefore questions the merit of a fixed 3.5-day rotational grazing system during the season, as was used in this study and on farms where lambs are forced to stay in camps for a specific period. Although it was found in this experiment that the turning point in ADG for rotational grazing is at a pasture yield of approximately 4 634 kg DM/ha, further research is necessary to determine the effect of different leaf availabilities on animal performance.

The data show that maximum gain/ha was achieved (optimum stocking rate) at 31 and 29 wethers/ha, with 1.902 and 1.782 kg/day for continuous and rotational grazing, respectively. The daily livemass gains at these optimum stocking rates are 61.4 g/day for continuous and 59.4 g/day for rotational grazing. The stocking rate used and grazing system applied on kikuyu with lambs will depend on the objective to be achieved by the grazier. The high stock density in a rotational grazing system may affect the individual performance of animals owing to possible stress and adverse social behaviour. This may justify further research.

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