Chemical composition and nutritive value of irrigated tall fescue pasture for dairy cows

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Irrigated tall fescue (*Festuca arundinacea*: Schreb) was evaluated over four seasons, in the spring and autumn, and was able to maintain a milk production of 15.5 kg FCM/d for medium-sized (550 kg) Friesian cows in mid-lactation, under a lax grazing programme. The response to concentrate feeding was 0.88 kg FCM/kg concentrate fed (*as fed* basis). The *in vivo* DOM of the pasture remained relatively high (within the range 61 — 63) during autumn even as the season progressed, whereas the DOM of the spring fescue declined markedly (from 62 to 57) as the grass set seed. However, this decline in the DOM value was not reflected in the milk production of the cows grazing the pasture, which indicates selective grazing.

Langswenkgras (*Festuca arundinacea*: Schreb) is oor vier seisoene geëvalueer. Frieskoeie van gemiddelde grootte (550 kg) in mid-laktasie het 'n melkproduksie van 15.5 kg VGM/d gehandhaaf op besproeide langswenkgrasweiding gedurende lente en herfs onder 'n ligte beweidingstelsel. Die respons op kragvoervoeding was 0.88 kg VGM/kg kragvoer gevoer (*soos gevoer* basis). Die *in vivo*-VOM het relatief hoog gebly (binne die grense 61 — 63) gedurende die herfs, selfs namate die seisoen gevorder het. Daarteenoor het die VOM van langswenkgras gedurende die lente vinnig afgeneem (vanaf 62 tot 57) met saadvorming. Hierdie afname in VOM is egter nie in die melkproduksie van die weidende koeie gereflekteer nie, wat 'n aanduiding van selektiewe weiding is.

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Tall fescue (*Festuca arundinacea*: Schreb) is a perennial cool season grass, with an active growth period in the spring and autumn. Among the attributes of fescue are good growth on poorly drained soils, excellent drought resistance and soil conservation characteristics (Buckner & Cowan, 1974), relative to other temperate species. However, many problems relating to animal performance, including fescue foot, fat necrosis and summer slump (fescue toxicosis), have been associated with tall fescue (Hemken *et al.*, 1984). Fescue toxicosis is caused by an endophyte infection of the pasture and, to the authors' knowledge, there has been only one isolated incident in South Africa.

Tall fescue is the third most common cultivated grazing species in Natal; kikuyu and Italian ryegrass being the most common grazing species (Heard *et al.*, 1983). The numerous reports on ruminants that eat tall fescue, grow at slower rates and produce less milk than ruminants that eat forages of similar chemical composition (Lassiter *et al.*, 1956; Seath *et al.*, 1956; Jacobson *et al.*, 1970; Warren *et al.*, 1974; Smith *et al.*, 1975; Reid *et al.*, 1975; Nichols *et al.*, 1976), prompted this investigation into the nutritive value and potential of fescue for dairy production in the Natal Midlands.

Experimental Procedure

The trials were conducted at the Cedara Agricultural Research Station (29° 32'S; 30° 17'E) in the Natal Mistbelt, at an altitude of 1 067 m with an average annual, predominantly summer rainfall of 855 ± 142 mm. The mean January maximum/minimum temperature is 25.1/14.9 °C, with heavy frosts occurring on the experimental site during the winter.

Pasture

A vlei area of 12 ha was established to tall fescue (cv. Kentucky 31), at 20 kg seed per hectare. The soil form was Katspruit and the initial fertilizer application rates were based on soil analysis, to achieve 20 p.p.m. phosphorus (0.05 N H_2SO_4 extractant), 150 p.p.m. potassium and an acid saturation of less than 10%.

Nitrogen fertilization was in the form of LAN (28% N), applied in three dressings of 250 kg/ha over the growing season: one at the start of the season (August), one in January and the final application in March. Phosphate and potash were applied annually if required, as determined by soil analyses.

The pasture was irrigated as required, to supply 25 mm water per week, throughout the growing season.

Digestion trials

Six steers, with an average mass of approximately 250 kg, were used per nine-day digestion trial, following a two-week adaptation period. The herbage was cut daily at 07:00 and fed to the steers in digestion crates. The technique used has been described by Juko *et al.* (1961).

Chemical analysis

Cut herbage samples were analysed for crude protein (CP) (Kjeldahl procedure; AOAC, 1980), true protein (TP) (trichloroacetic acid procedure; Marais & Evenwell, 1983), crude fibre (CF) (Bredon & Juko, 1961), ether extract (EE), dry matter (DM) and ash (AOAC, 1980).

Estimation of fescue intake

A trial was conducted in conjunction with the autumn 1985 grazing trial, using 30 lactating dairy cows. Intake was determined at three levels of concentrate supplementation, namely 3, 6 and 9 kg/cow/d, to quantify the substitution effect of concentrates on fescue intake. The total dry matter available and the residual dry matter after grazing were determined by a pasture disc meter (Bransby & Tainton, 1977), following calibration of the technique for fescue. The disc meter was calibrated using 50 samples for the IN reading and 50 samples for the OUT readings. The disc height was regressed against the actual DM yield cut at ground level under the disc. Dry matter disappearance was determined by measuring the pre-grazing herbage mass and the residual herbage mass after grazing a known area for two days, following adaptation, and intake was determined by difference.

Milk production trials

Grazing trials

Four grazing trials were conducted, two in spring and two in autumn, during the active growth periods of fescue. The trials were run for a minimum period of six weeks, the ultimate trial length depending on the regrowth of the pasture.

The chemical composition and *in vivo* digestibility of the pastures were determined for each grazing trial. Disc meter data were also collected for each grazing trial.

Experimental design

A short-term post-peak experimental design (Stobbs & Minson, 1983; Wickes, 1983) was used as the growing season of the pasture was too short to allow for full lactation studies. A randomized block design was used, blocking for live mass, stage of lactation, lactation number, milk production and butterfat percentage, to reduce the variation between treatments (Stobbs & Minson, 1983; Wickes, 1983).

Experimental treatments

Thirty Friesian cows of medium size (*ca* 550 kg) were blocked into three treatments according to milk yield, butterfat percentage, body mass and stage of lactation. These cows were used to determine the milk production responses to different levels of concentrate supplementation. Concentrates were supplemented on the basis that the fescue would supply sufficient nutrients for:

Treatment 1: maintenance + 6 kg milk per day (M + 6)
Treatment 2: maintenance + 11 kg milk per day (M + 11)
Treatment 3: maintenance + 16 kg milk per day (M + 16)

The concentrates were fed at a rate of 600 g/kg of milk above the levels specified for each treatment. The concentrate allocations were then kept constant for the duration of the six-week trial to avoid adaptation problems, thereby allowing the milk yields to equilibrate with energy inputs. Blaxter (1956) has shown that this response is achieved within three weeks. The concentrates were formulated to contain 14% CP and 11.1 MJ ME/kg *as fed*. Minerals were supplemented according to Bredon & Stewart (1979).

Animal management

The cows grazed on the fescue during the day and the night and were removed for milking twice a day. Concentrates were fed after milking in a post-parlour feeder. The animals were weighed fortnightly after morning milking without prior starvation.

The pasture was grazed in a four-week rotational grazing system, with fresh pasture allocated daily. Follower animals were used to remove residual grazing when required.

Experimental data recorded

Milk yields were recorded daily, whereas butterfat (BF) and protein levels were determined every fortnight using an infrared analyser (Taurus laboratories, Baynesfield). Individual body mass changes were also determined fortnightly.

Biometrical analysis

Multiple regression (Genstat V) techniques were used to determine the milk production responses to concentrates.

Results

Chemical composition and digestibility of fescue grazing

The chemical composition and the associated digestibility coefficients of tall fescue are presented in Table 1.

The digestible organic matter (DOM) of the pasture remained relatively high, within the range 61—63, during the autumn even as the season progressed, whereas the DOM of the spring fescue declined markedly as the grass started seeding. This decline in the DOM value was not reflected in

Table 1 Chemical composition and digestibility of tall fescue (cv. Kentucky 31) (DM basis)

	Chemical composition (%)					Digestion coefficient (%)					
	CP	CF	EE	NFE	OM	CP	CF	EE	NFE	OM	DOM (%)
Spring growth											
Leafy	19.1	24.7	1.9	42.5	88.2	76.2	73.0	41.2	66.8	70.0	61.7
Flowering	14.6	30.5	1.2	42.2	88.6	71.2	71.9	19.3	63.3	66.9	59.3
Full seed	11.6	29.2	1.8	46.8	89.4	65.3	65.3	48.2	62.7	63.6	56.8
Autumn growth											
Early April	21.7	23.5	2.7	43.4	91.3	79.1	67.6	53.4	65.3	68.8	62.8
Late April	18.4	22.3	3.5	45.6	90.7	75.2	68.7	55.1	68.6	69.3	62.8
Mid-May	14.1	22.4	2.5	51.5	90.4	69.3	63.6	38.6	70.6	67.8	61.2

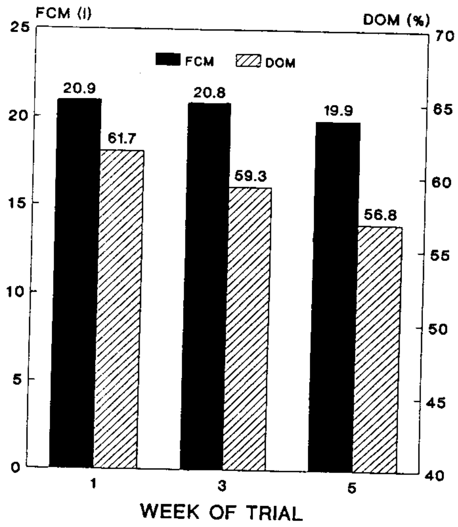

Figure 1 Milk production of cows that grazed spring tall fescue setting seed, relative to the DOM of the pasture.

the milk production of the cows grazing the pasture (see Figure 1), which indicates selective grazing.

The CP and TP levels in the herbage were significantly ($P < 0.001$) correlated and the relationship is described by the following equation:

$$TP(\%) = 0.87 + 0.70(CP\%);\ n = 27;\ r = 0.911;\ P < 0.001.$$

The proportion of CP in the form of NPN (24%) is within the expected range of local cultivated pasture. McDonald *et al.* (1981) have stated that as much as 30% of the nitrogen in ruminant feeds may be in the form of simple organic compounds or inorganic compounds which constitute NPN.

Table 2 shows the chemical and mineral composition of the tall fescue grazing, on a dry-matter basis.

Table 2 Average chemical and macro-mineral composition of the tall fescue grazing, on a dry-matter basis

	Mean ± *SE* (%)	Range (%)
CP	16.15 ± 3.48	12.15—24.01
TP	12.35 ± 2.67	8.96—17.28
NPN (% of CP)	24.31 ± 6.19	11.55—34.11
CF	25.67 ± 2.32	21.84—29.15
EE	1.35 ± 0.33	0.34— 1.90
Ash	10.52 ± 0.99	8.32—11.51
Ca	0.32 ± 0.08	0.19— 0.46
P	0.26 ± 0.03	0.18— 0.29
K	2.79 ± 0.33	1.91— 3.04
Mg	0.28 ± 0.04	0.18— 0.34

Dry-matter intake

Equations to predict fescue dry-matter yield, using a pasture disc meter, are summarized in Table 3 and the intake data in Table 4.

The DMI of 14.45 kg for the 3 kg concentrate level is slightly lower than expected when compared to the DMI measured on ryegrass pasture without concentrate supplementation at Cedara for 24-h grazing (Bredon & Stewart, 1979).

Table 3 Equations to predict fescue yield (kg DM/ha) using a pasture disc meter

Pre-grazing

DM yield (kg/ha) = 377.486 + 301.229 (disc height); $r = 0.587$; $n = 50$; $P < 0.001$.

Post-grazing

DM yield (kg/ha) = 745.4 + 179.494 (disc height); $r = 0.545$; $n = 50$; $P < 0.001$.

Table 4 Estimated dry-matter intakes (DMI) of cows that grazed tall fescue and were fed different levels of concentrates

Conc. level (kg)	*n*	Disc height (cm) Pre-graze	Post-graze	Estimated fescue intake (kg DM)	Total DMI (kg)
9	24	5.19	4.91	6.83	14.84
6	24	9.51	6.56	19.82	25.22
3	24	9.16	7.94	11.78	14.45

The data are not entirely consistent, with the 6 kg concentrate level recording an increased DMI of approximately 10 kg over the other treatments at 25.22 kg DM/d. This intake is far in excess of the expected DMI for dairy cows on that quality diet. The DMI of 14.84 kg for the 9 kg concentrate level is low when compared with the expected DMI of Friesian cows, derived by Bredon & Stewart (1979).

Milk production trials

Milk production data for the first grazing trial conducted during the spring of 1982 growth period are presented in Table 5. These data clearly show that the potential of fescue was underestimated for the spring-1982 trial, as reflected by the minimal response to increased levels of concentrates, and confirmed by regression analyses (Table 6) of the data. Cows in the M+16 treatment experienced a slight negative energy balance, since mass losses occurred during the trial period. The levels were therefore revised before the spring-1985 and subsequent grazing trials. The revised levels were:

Treatment 1: M + 15;
Treatment 2: M + 18;
Treatment 3: M + 21.

Table 5 Milk production in cows that grazed tall fescue and were fed different levels of concentrates, during spring 1982

	Treatment M+6	M+11	M+16
Cows per treatment	10	10	8[a]
Milk yield (kg/d)	21.1 ± 4.4	20.1 ± 4.9	20.0 ± 4.5
BF (%)	4.15 ± 0.2	4.24 ± 0.6	4.23 ± 0.4
FCM (kg/d)	21.6 ± 4.6	20.5 ± 4.0	20.7 ± 4.5
Concentrates fed (kg/d)	9.1 ± 2.3	5.9 ± 2.9	3.0 ± 2.3
Initial cow mass (kg)	538 ± 52.7	525 ± 45.8	528 ± 47.7
Mass changes (kg/d)	0.16 ± 0.2	−0.05 ± 0.2	−0.12 ± 0.2

[a] Two cows stolen during trial.

Table 6 Regression equations describing the milk production (FCM) response to concentrate feeding of cows that grazed fescue pasture, where X_1 = kg concentrates and X_2 = body mass in kg

Spring 1982	: FCM = 15.38 + 0.90 (X_1);	n = 28 ;	r = 0.707;	$P < 0.001$
Spring 1985	: FCM = 17.8 + 0.801 (X_1);	n = 23 ;	r = 0.649;	$P < 0.01$
Autumn 1986	: FCM = 14.8 + 0.80 (X_1);	n = 21 ;	r = 0.581;	$P < 0.01$
Autumn 1987	: FCM = 14.9 + 0.38 (X_1);	n = 17*;	r = 0.270;	$P > 0.05$
Pooled data	: FCM = 15.5 + 0.88 (X_1);	n = 82 ;	r = 0.663;	$P < 0.001$
Pooled data	: FCM = 8.47 + 0.88 (X_1) + 0.013 (X_2);	n = 82 ;	r = 0.678;	$P < 0.001$

* Four cows withdrawn due to health problems.

Although there were no significant differences between treatments applied during the spring of 1982, there was sufficient variance within treatments to provide a range of milk yields and related concentrate allocations. A regression analysis described a significant relationship relating the milk production response to concentrates as 0.9 kg fat corrected milk (FCM) per kg of concentrate fed (Table 6), above a production level of 15 kg FCM/d.

Four cows were withdrawn from the autumn-1987 trial due to disease, thus limiting animal numbers to 17, and this probably resulted in the non-significant effects.

The BF percentages recorded during the trials (*ca* 3.9%; see Table 7) did not differ significantly between treatments and were comparable to the average for the Cedara Friesian herd, which has an inherently high BF level. The protein concentrations of the milk (*ca* 3.2%) did not differ significantly between treatments and also approximated the average for the Cedara herd, which indicates that fescue grazing did not adversely affect milk composition, even at relatively high (9 kg) concentrate levels.

Discussion

Leaver (1985) has suggested that the intake of herbage by grazing dairy cows is the major factor limiting milk production from pasture on temperate grassland, because the peak potential intake for high-yielding cows can be over 3.25% of live mass on a variety of diets, whereas daily intakes of grazed herbage are normally below 3.0% of live mass. Even considering the inaccuracies in determining DMIs in this trial, this statement by Leaver (1985) is apparently true for the data obtained in the present study.

Table 7 Milk yields and milk composition, of mid-lactation cows that grazed tall fescue and were fed differing levels of concentrates

	Treatment		
	M+15	M+18	M+21
		Spring 1985	
Milk (kg FCM)	21.9 ± 1.7	22.4 ± 1.7	22.7 ± 3.6
BF (%)	3.9 ± 0.4	4.2 ± 0.5	3.9 ± 0.2
Protein (%)	3.3 ± 0.2	3.3 ± 0.1	3.2 ± 0.2
Concentrates (kg/d)	6.6 ± 1.6	4.9 ± 2.1	2.8 ± 2.2
		Autumn 1986	
Milk (kg FCM)	18.7 ± 2.9	18.4 ± 2.2	17.3 ± 2.9
BF (%)	3.8 ± 0.4	3.9 ± 0.3	3.9 ± 0.2
Protein (%)	3.0 ± 0.1	3.0 ± 0.2	3.1 ± 0.2
Concentrates (kg/d)	6.1 ± 1.5	3.6 ± 1.2	2.1 ± 1.5
		Autumn 1987	
Milk (kg FCM)	19.2 ± 2.4	18.7 ± 1.7	16.1 ± 3.9
BF (%)	3.6 ± 0.3	3.5 ± 0.2	3.8 ± 0.3
Protein (%)	3.3 ± 0.3	3.2 ± 0.3	3.4 ± 0.2
Concentrates (kg/d)	9.0 ± 0.0	6.0 ± 0.0	3.0 ± 0.0

The use of the disc meter for estimating DMI of grazing animals has not been found to be entirely successful for these data, as well as for steers on kikuyu (Dugmore, unpublished data) and sheep on kikuyu (De Villiers, personal communication) at Cedara. This is possibly due to the fact that under the lenient grazing pressure applied, the error of estimation of DM yields is often larger than the actual amount of material removed from the pasture. Minson *et al.* (1976) have stated that feed intake can be estimated by measuring the difference between pasture mass before and after grazing. This method has proved satisfactory with strip grazing and when there is almost complete utilization of the pasture. However, where such conditions do not apply, the error of estimation is too large (Minson *et al.*, 1976). It is unfortunate that, despite intensive research during the past thirty years, techniques for the precise estimation of the intake of grazing animals have not yet been developed (Stobbs & Minson, 1983), or even appear likely to be developed in the near future (Minson, 1981). Methods such as the use of intra-ruminal slow-release capsules of chromium sesquioxide (Dobos, 1990) and n-alkanes (Laredo *et al.*, 1991) show promise for determining intake by indidvidual grazing cows. However, Laredo *et al.* (1991) have found that the differences in alkane concentration between leaf and stem fractions and between leaves of different ages could have led to large errors in estimating the intake where forage is strip or rotationally grazed. Furthermore, these methods require that the animals graze the same area of pasture for several days and therefore have limitations under rotational grazing systems, where the recommended period of stay is one day, or even less, for dairy cows. The use of these methods may be viable for research applications, but there is still a lack of a practical accurate method to determine intake at the farm level.

The inability to accurately determine the intake of the grazing dairy cow has enormous practical consequences in ration balancing for grazing cows. This has led to the 'simplified feeding' concept (Ostergaard, 1979), where roughages are offered *ad lib* to overcome the problem of determining roughage intake, and concentrates are fed at fixed levels irrespective of milk yield, *i.e.* flat rate, where the level of concentrates allocated depends on their cost and the milk response to the concentrates. The inability to accurately determine grazing intake did not affect the major emphasis of this trial, namely the determination of the milk production response to concentrates on fescue pastures at light stocking rates.

The intercepts from the regression equations presented in Table 6 indicate that, at zero concentrates, dairy cows (550 kg medium-sized Friesian cows) on fescue can produce 15 kg FCM/d. Cows fed no concentrates during the spring-1985 trial confirmed this level of production (14.94 kg FCM/cow). Other researchers (Blaser *et al.*, 1969) have found that cows grazing tall fescue without concentrates produced on average 13.4 kg FCM.

The response of 0.88 kg FCM/kg concentrate for the pooled data (Table 6) is higher than the typical response measured on temperate grasses in New Zealand. For a large number of experiments these were 0.3 kg milk per kg concentrate, at relatively high allowances of pasture (Leaver *et al.*, 1968; Holmes & Wilson, 1984). The response of 0.88 kg FCM/kg concentrate is far higher than expected from temperate pastures in a temperate region. This was possibly due to reduced digestibility of herbage in the present study, associated with high environmental temperatures and decreased latitude (Wilson, 1982), relative to the temperate regions.

The higher responses recorded for the data in this study relative to other studies could be attributed to a lower substitution of roughages by concentrates on the experimental pastures. Holmes & Jones (1964) have derived the equation: $I = 2.8 - 0.034$ OMD, where I is the increase in DMI for every kg of concentrates consumed and OMD is the organic matter digestibility. According to this equation, the increased intake, at an OMD of 68, for every kg increase in concentrates fed in the present study was 0.49 kg/d. This contrasts with an expected increase of 0.08 kg/d on good quality temperate pastures in temperate regions, defined by Leaver (1981) as having 11 MJ ME/kg DM (OMD = 80; AAC, 1990).

The health problems encountered in the autumn-1987 trial were not related to any of the known problems encountered on fescue.

In conclusion, tall fescue pasture, in the spring as well as autumn, was able to maintain a milk production of 15.5 kg FCM for medium-sized (550 kg) Friesian cows in mid-lactation, under a lax grazing programme over several seasons. The response to concentrate feeding was 0.8—0.9 kg FCM/kg concentrate fed (*as fed* basis). The ratio of current milk price to commercial concentrate price still justifies the use of concentrates during mid-lactation as being economically sound.

Fescue, which has been shown to have relatively good potential for dairy cows, should be considered in any fodder flow design for dairy farmers. It is ideally suited to vlei-type situations, where annual cultivation is not advisable or even possible. Fescue, however, cannot compete with ryegrass for prime irrigation land because of its poorer mid-winter production; a critical factor in milk production off pasture systems in Natal.

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