Benefits of urea-molasses block supplementation and symptomatic and tactical anthelmintic treatments of communally grazed indigenous goats in the Bulwer area, KwaZulu-Natal Province, South Africa

A F Vatta[a,b*], J F de Villiers[c], S A Gumede[c], R C Krecek[d,e], N P Mapeyi[c], R A Pearson[f], M F Smith[g], M O Stenson[a] and L J S Harrison[f]

ABSTRACT

This study was carried out with the cooperation of farmers owning communally grazed indigenous goats in southwestern KwaZulu-Natal Province, South Africa, where farmers had identified poor reproductive performance in their herds as one of their major problems. The aim was to quantify the effects of 3 interventions and the interaction between these interventions on goat productivity and gastrointestinal nematode infection. The interventions were: urea-molasses block supplementation during the dry winter seasons of 2004 and 2005, tactical anthelmintic treatment with ivermectin (400 μg/kg) during the wet summer period (on 3 January 2005) and symptomatic treatment with ivermectin (400 μg/kg) of all goats judged anaemic throughout the entire study period. The FAMACHA© system was used as a gauge of anaemia. It was noted that goats considered anaemic tended to remain so throughout the study period. The tactical anthelmintic treatment was effective as it markedly reduced ($P = 0.066$) the summer peak in faecal egg counts and is therefore recommended. By contrast, while the urea-molasses block supplementation appeared to reduce the faecal egg counts immediately following the 2004 supplementation ($P < 0.05$), this did not hold true in 2005. Interestingly, in the tactically treated anaemic goats, the improvement in the number of kids suckled per doe year-on-year tended to be greater than in the non-anaemic goats. It is considered that the routine symptomatic treatment of anaemic goats may have been a key factor. More detailed investigations into the routine symptomatic treatment of anaemic goats are therefore recommended.

Key words: FAMACHA©, gastrointestinal nematodes, symptomatic and tactical anthelmintic treatment, urea-molasses blocks, Zulu goats.

Vatta A F, de Villiers J F, Gumede S A, Krecek R C, Mapeyi N P, Pearson R A, Smith M F, Stenson M O, Harrison L J S **Benefits of urea-molasses block supplementation and symptomatic and tactical anthelmintic treatments of communally grazed indigenous goats in the Bulwer area, KwaZulu-Natal Province, South Africa**. *Journal of the South African Veterinary Association* (2007) 78(2): 81–89 (En.). Onderstepoort Veterinary Institute, Private Bag X05, Onderstepoort, 0110 South Africa.

INTRODUCTION

In the summer rainfall area of South Africa internal helminth parasites are an important cause of disease in communally grazed indigenous goats belonging to resource-poor farmers of KwaZulu-Natal Province, South Africa[19,20]. Dry-season (winter) feed scarcity was identified as an important constraint to improving goat productivity in these animals[20]. Resource-poor communities have also indicated that poor reproductive performance of goats is a major concern[7]. Studies with Boer goats on extensive grazing at Onderstepoort Veterinary Institute, Gauteng Province, in the summer rainfall area of South Africa showed that urea-molasses block supplementation during the dry winter period (June to August) resulted in heavier cold dressed-out carcase weights compared with weights of non-supplemented controls[18]. The increase in carcase value showed that supplementation was economically justifiable. The aim of the present investigation was to quantify the effects of 3 interventions and the interaction between these interventions on gastrointestinal nematode infection and goat productivity. The interventions were: urea-molasses block supplementation during the dry winter seasons of 2004 and 2005, tactical anthelmintic treatment during the wet summer period and symptomatic treatment of all goats judged anaemic throughout the entire study period. The FAMACHA© system was used to identify anaemic goats as this is simple and practical for use on farms[3].

MATERIALS AND METHODS

Selection of the farms and goats used in the study

The study area, comprising the 3 goat-keeping communities of Nkwezela, Hlafuna and Njobokazi, near Bulwer, falls within the Moist Highland Sourveld and Moist Tall Grassveld Bioresource Groups[4]. The topography comprises rolling hills to mountainous areas and is primarily suited to extensive livestock production[4]. The homesteads of the participating farmers were situated at 1214 to 1532 m above sea level. With the exception of January and February 2004, the monthly rainfall for Bulwer was similar to the average monthly rainfall for 1990–2002 (Fig. 1).

Farmers with at least 7 weaned does were identified within the study area and were invited to participate in the experiment. Three farmers' goat herds were included from each of the villages of Nkwezela and Njobokazi and 2 from Hlafuna. Within each village, the farmers' goats were extensively grazed on communal pastures.

The ages of the experimental goats were determined at the start of the experiment by examination of the lower incisors and scored as 0-, 2-, 4-, 6- or 8-tooth animals[12], where the number corresponds to the number of erupted permanent incisors. For statistical analysis, the goats were divided into younger animals (having 4 or fewer permanent incisor teeth and estimated to be 18–21 months old or

[a]Onderstepoort Veterinary Institute, Private Bag X05, Onderstepoort, 0110 South Africa.

[b]University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209 South Africa.

[c]Farming Systems Research Section, KwaZulu-Natal Department of Agriculture and Environmental Affairs, Private Bag X6005, Hilton, 3245 South Africa.

[d]Krecek and Krecek CC, P.O. Box 12832, Onderstepoort, 0110 South Africa.

[e]Present addresses: Ross University School of Veterinary Medicine, St Kitts, West Indies and University of Johannesburg, Johannesburg, South Africa.

[f]University of Edinburgh, Royal (Dick) School of Veterinary Studies, Division of Veterinary Clinical Science (incorporating Centre for Tropical Veterinary Medicine), Easter Bush Veterinary Centre, Easter Bush, Roslin, Midlothian, EH25 9RG United Kingdom.

[g]Biometry Unit, Agricultural Research Council, Private Bag X519, Silverton, 0127 South Africa.

*Author for correspondence. E-mail: vattaa@arc.agric.za

Received: January 2007. Accepted: June 2007.

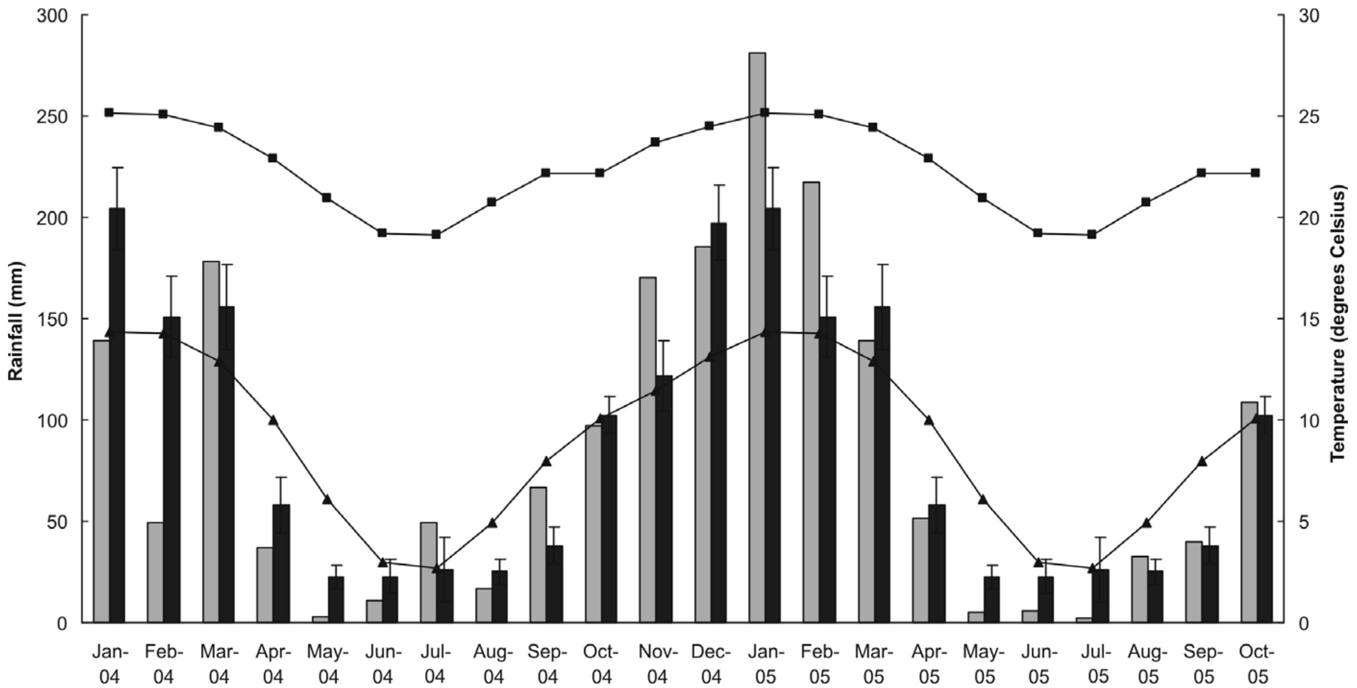

Fig. 1: **Monthly rainfall data for Bulwer, South Africa, over the experimental period** (light-grey columns)**, the average monthly rainfall data for Bulwer for 1990–2002** (black columns) **and the average maximum (■) and minimum (▲) monthly temperatures for Emerald Dale, the nearest weather station to Bulwer that recorded temperature data for the period 1990–2002.**

younger[12]) or older animals (having more than 4 permanent incisor teeth and being older than 18–21 months of age). The goats were identified by numbered ear-tags inserted at the start of the study.

Pasture sampling

Herbage samples were collected from 6 grazing areas of the village herds on 30–31 August 2004, 25–26 October 2004, 2–3 February 2005 and 25–26 May 2005, dates that fell within the 4 different seasons. The seasons were defined as winter: 1 June to 31 August; spring: 1 September to 30 November; summer: 1 December to 28 February; and autumn: 1 March to 31 May. The 6 sites were designed to encompass the various common grazing ranges of the goats on the hillsides. During each collection period, herbage samples were collected by cutting or plucking the grass and herbs falling within a quadrat of 400 mm × 400 mm thrown at random on 10 occasions in each of the 6 grazing areas. The positions where the quadrat fell were identified on the 1st visit by means of GPS points. The same points were located on each subsequent visit and the quadrat was then thrown from these points during the subsequent visits. The samples from each grazing area were then pooled by site for analysis, as were the various components such as leaves, stems and grass. Samples of browse leaves from shrubs falling within ~3 m of the place where the quadrat fell were also collected. The samples were dried, milled and analysed by proximate analysis for dry matter, lipid and ash content[1], crude protein[2], acid detergent fibre and neutral detergent fibre[16].

Monitoring and sampling

During the 4-weekly visits to the homesteads, from February 2004 to October 2005, the weaned and adult does were weighed with a spring balance able to weigh to 200 kg in 500 g increments (Salter Model 235, Capital Scales, Pretoria, South Africa) and their body condition scored on a scale of 1 (very thin) to 5 (obese)[14,22]. At the same time, blood was collected from the jugular vein into evacuated ethylene diamine tetra-acetic acid (EDTA) tubes (Vacutainer Systems, Becton Dickinson, France). The blood was stored in an ice-filled cooler box for transport to a field laboratory and was processed on the same day as collection. Two heparinised microhaematocrit tubes (Brand, Wertheim, Germany) were filled with blood per sample and centrifuged (Hermle Z230 HA, Germany) for 8 minutes at 12 000 revolutions per minute. The haematocrits were read for the 2 microhaematocrit tubes and the mean of the 2 readings used in the analyses. Faecal samples were obtained for faecal nematode egg counts[13]. Faeces were also collected from the experimental animals and from the other goats in the herd for pooled culture for 3rd-stage nematode larvae from May 2004 to October 2005. The faeces were transported in an ice-filled cooler box or stored in a refrigerator until processing in the laboratory. Cultures were made according to Reinecke[13] and identification of the larvae was done following the key of Van Wyk *et al.*[17].

Faecal trematode egg counts were carried out according to the method of Malan and Visser[11] at 4-weekly intervals from 3 January 2005 onwards. When 2 study animals were found to be positive for *Fasciola* spp. eggs on faecal trematode egg count on 3 January 2005, all the goats in the herds were treated with triclabendazole (Fasinex, Novartis South Africa) at a dosage of 10 mg/kg on 31 January or 1 February 2005 and again on 25 or 26 April 2005. The trematode egg counts remained negative for *Fasciola* spp. eggs from 28 February 2005 onwards until the end of the study.

The goats were evaluated according to the FAMACHA© system, a method of assessing anaemia which has been tested for use where *Haemonchus contortus* infection is the cause of anaemia[10,21]. The colour of the conjunctival mucous membranes is compared with a colour chart depicting 5 gradations of red from '1' to '5', '1' (red) corresponding to 'healthy' and '5' (white) to 'severely anaemic'. Goats that were scored as 3, 4 or 5 were considered anaemic. The scoring was done by the farmer or the farmer's assistant (e.g. a son or daughter or herdsman) under the guidance of an experienced evaluator (M D Chipana, M O Stenson or A F Vatta), or by the experienced evaluator himself.

The farmers were asked whether the does were suckling kids (0, 1 or 2 kids) and this information was recorded. Data for 56 does were included in the final analysis.

Table 1: **Experimental interventions carried out in 6 groups of communally grazed indigenous goats** (Bulwer, South Africa) **– supplemented** (BLOCK) **or not supplemented** (NO-BLOCK) **with urea-molasses blocks and tactically treated** (TT) **with ivermectin when scored as anaemic** (F©/TACT)**, when scored as non-anaemic** (NON-F©/TACT) **or not tactically treated** (NON-F©/NON-TACT)**. Goats were symptomatically treated with ivermectin if scored as anaemic on examination of the conjunctival mucous membrane** (according to the FAMACHA© system)**.**

Group (*n*)	2004											2005									
	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O
F©/TACT/BLOCK (10)					B L O C K S							TT					B L O C K S				
F©/TACT/NO-BLOCK (17)												TT									
NON-F©/TACT/BLOCK (6					B L O C K S							TT					B L O C K S				
NON-F©/TACT/NO-BLOCK (7)												TT									
NON-F©/NON-TACT/BLOCK (6)					B L O C K S												B L O C K S				
NON-F©/NON-TACT/NO-BLOCK (10)																					

Experimental design

The experimental interventions are summarised in Table 1. From the end of May until the end of September 2004 and again from the beginning of June to the end of September 2005, 3 of the 8 herds were supplemented with urea-molasses blocks (Voermol Protein Blocks, Voermol, South Africa) in the animals' kraals (sleeping pens) located at the homesteads. Because management constraints made it impossible to separate supplemented (BLOCK) and unsupplemented (NO-BLOCK) animals within individual herds, each herd was allocated to either the one or the other of the 2 treatments. The decision on which herds to supplement was based on the presence of a protective roof for the urea-molasses blocks and the need to ensure a comparison between farmers within villages. Hence 1 herd within Nkwezela and 1 each from Hlafuna and Njobokazi were supplemented. Only 1 block was placed in each kraal of supplemented goats at a time. No dominant behaviour of any goats, which would have prevented or limited block consumption by any of the others was observed or reported.

Irrespective of experimental grouping, every goat clinically evaluated throughout the experiment according to the FAMACHA© system as being anaemic, was treated with ivermectin (Ivomec Liquid, Merial South Africa) at a dosage of 400 μg/kg. Within each herd, the does were randomly allocated to 2 groups balanced for live weight, using the live weights for 6 December 2004. One group was given a tactical treatment with ivermectin irrespective of mucous membrane colour on 3 January 2005; the 2nd group was left untreated, except where animals received symptomatic treatment for anaemia. Tactical anthelmintic treatment is defined as deworming when large worm burdens are expected[15]. Thus there were 4 groups of goats: (a) goats that had FAMACHA© scores of 1 or 2 that were not treated (non-anaemic-scored and not tactically treated group, NON-F©/NON-TACT group); (b) goats that had FAMACHA© scores of 1 or 2 that were tactically treated (non-anaemic-scored and tactically treated group, NON-F©/TACT group); (c) goats classified according to FAMACHA© score as anaemic on 3 January 2005, that had been selected according to live weight on 6 December 2004 for tactical treatment; and (d) goats FAMACHA©-scored as anaemic that had not been selected for tactical treatment, but which were treated because they were considered anaemic. The data for groups (c) and (d) were combined for the analyses (anaemic-scored and tactically treated group, F©/TACT group).

Statistical analysis

The data were analysed statistically by means of a 2 × 3 factorial analysis of variance (ANOVA) for unbalanced data using the GenStat statistical software (GenStat® for Windows® 7th edition, VSN International Ltd). Both the main effects of urea-molasses block supplementation (2 levels) and tactical anthelmintic treatment (3 levels) were examined as well as the interaction of supplementation by tactical anthelmintic treatment. The data were further analysed for effects of age and supplementation, the age by supplementation interaction, age and tactical anthelmintic treatment, and the age by tactical anthelmintic treatment interaction. Treatment means were separated using Fisher's protected *t*-test least significant difference at the 5 % level. The data for the faecal egg counts were log-transformed ($y = \log_{10}$ (egg count + 1)) to stabilise treatment variances, but the untransformed values are reported in the text and figures.

RESULTS

The dry matter content of the herbage was highest during the late dry season, winter sampling time (August 2004) and lowest during the late wet season, summer sampling time (February 2005) (Table 2). The crude protein content of the herbage was lowest during the early dry season (May 2005) and highest during the spring sampling time (October 2004).

The consumption of urea-molasses blocks by BLOCK goats during the dry, winter season was estimated to be 42 g per goat per day for both the 2004 and 2005 supplementation periods. The amount of block consumed per goat was estimated by dividing the total amount of block

Table 2: **Average composition of herbage sampled on 30–31 August 2004, 25–26 October 2004, 2–3 February 2005 and 25–26 May 2005 at 6 sites encompassing the various common grazing ranges of the study goats, in Bulwer, South Africa.**

	Dry matter (g/kg)	Moisture (g/kg)	Crude protein (g/kg DM)	ADF (g/kg DM)	NDF (g/kg DM)	Lipid (g/kg DM)	Ash (g/kg DM)
Mean	411.3	588.7	75.6	453.2	773.5	21.6	92.5
SD	126.1	126.1	26.7	49.4	57.9	7.8	24.2
SE	22.3	22.3	4.7	8.7	10.2	1.4	4.3
Minimum	266.4	235.8	37.2	371.3	666.2	12.4	52.0
Maximum	764.2	733.6	124.4	574.6	873.0	48.4	174.7
n	24	24	24	24	24	24	24

Key: SD: standard deviation; SE: standard error; DM: dry matter; ADF: acid detergent fibre; NDF: neutral detergent fibre.

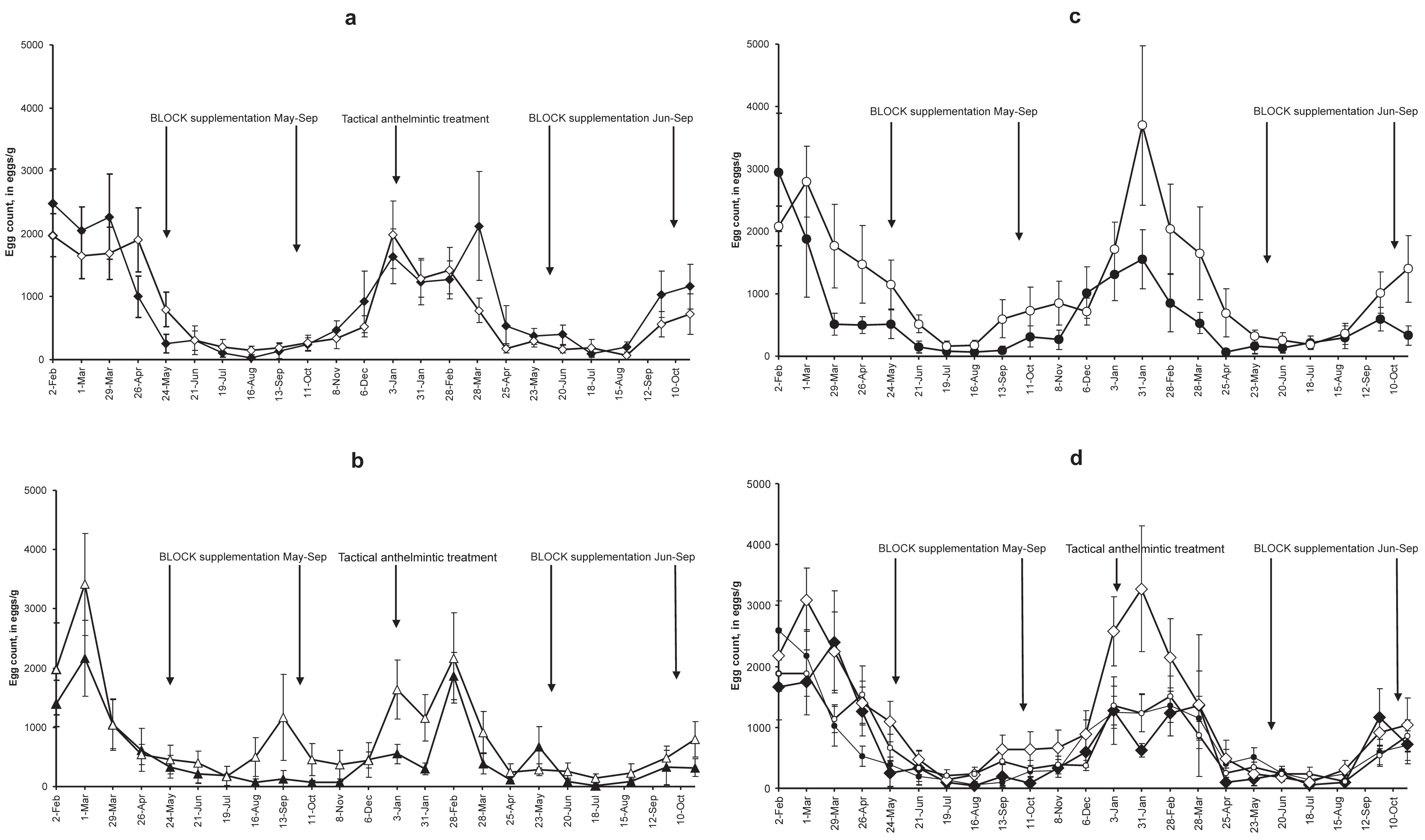

Fig. 2: **Mean faecal nematode egg counts** (in eggs per gram of faeces) **for 6 groups of communally grazed indigenous goats in Bulwer, South Africa, over the experimental period** (February 2004 to October 2005)**.** a: **The faecal egg counts for the F©/TACT/BLOCK group** (◆, anaemic-scored group, supplemented with urea-molasses blocks and tactically treated with ivermectin**) compared with those for the F©/TACT/NO-BLOCK group** (◇, anaemic-scored group, tactically treated with ivermectin but not supplemented with urea-molasses blocks). b: **The faecal egg counts for the NON-F©/TACT/BLOCK group** (▲, non-anaemic-scored group, supplemented with blocks and tactically treated with ivermectin) **compared with those for the NON-F©/TACT/NO-BLOCK group** (△, non-anaemic-scored group, tactically treated with ivermectin but not supplemented with blocks)**.** c: **The faecal egg counts for the NON-F©/NON-TACT/BLOCK group** (●, non-anaemic-scored group, supplemented with blocks but not tactically drenched with anthelmintic) **compared with those for the NON-F©/NON-TACT/NO-BLOCK group** (O, non-anaemic-scored group, not supplemented with blocks and not tactically treated with anthelmintic)**.** d: **The faecal egg counts for the younger goats which were either supplemented** (BLOCK, ◆) **or not supplemented** (◇) **with urea-molasses blocks compared with those for the older goats which were either supplemented** (BLOCK, ●) **or not supplemente**d (O) **with urea-molasses blocks.**

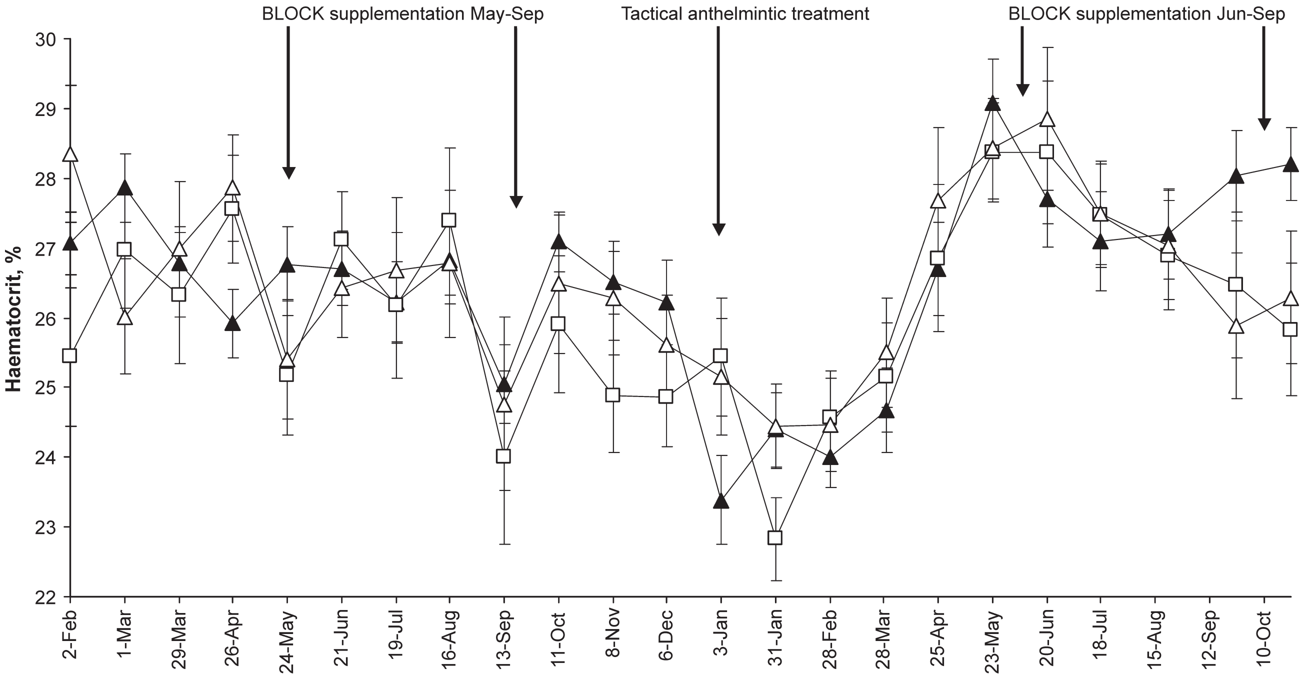

Fig. 3: **The mean haematocrits for the anaemic-scored** (F©/TACT, ▲) **and non-anaemic-scored** (NON-F©/TACT, △) **groups of goats that were tactically treated with ivermectin and for the non-anaemic-scored group that was not tactically treated** (NON-F©/NON-TACT, □)**, Bulwer, South Africa.**

consumed by the total number of goats in the herd, including animals not included in the study.

Examination of 3rd-stage nematode larvae derived from faecal cultures showed a predominance of *Haemonchus* larvae throughout the study period, but *Teladorsagia/Trichostrongylus* larvae occurred in higher percentages than the other larvae during the months of July and August 2004 and at the end of January and in May and July 2005 (data not shown). Larvae of *Oesophagostomum*, *Strongyloides* and *Gaigeria/Bunostomum* occurred in very low numbers (on average, making up less than 5 % of the larvae recovered, except for August 2005 when *Oesophagostomum* larvae averaged 18 %).

Tactical anthelmintic treatment had a transitory effect on the faecal egg counts (P = 0.066 for 31 January 2005). These decreased in TACT goats following treatment, but returned to levels similar to those of the NON-F©/NON-TACT goats within 8 weeks following the treatment (Fig. 2a–c; P = 0.760 for 28 February 2005). Importantly, the tactical treatment prevented the summer, wet season peak in egg counts which was seen during February in the NON-F©/NON-TACT goats. There was no apparent long-term effect on egg counts following the tactical treatment.

The urea-molasses supplementation appeared to have an effect on egg counts in August and September 2004 and the end of January 2005 when the BLOCK animals had significantly lower egg counts (P < 0.05) than the NO-BLOCK animals. Otherwise, the differences in egg counts between the BLOCK and NO-BLOCK animals were not statistically significant (P > 0.05). There were no significant differences for the interaction of tactical treatment and urea-molasses block supplementation on egg counts (P > 0.05).

Although never significantly so, the faecal egg counts for the younger animals (with 4 or fewer permanent incisor teeth) were generally higher than those of the older animals and this difference was greater during the warmer, wetter months of January to March. The age of the animals did not affect the effectiveness of the tactical treatment. The interaction of age and supplementation was significant only on 24 May 2004 and 3 January 2005 (P < 0.05; Fig. 2d). The NO-BLOCK younger goats had the highest egg counts at these times, which were significantly higher than the egg counts of the BLOCK younger goats (P = 0.004) in May 2004 and tended towards being significantly higher than the egg counts of this group on 3 January 2005 (P = 0.083).

The average haematocrit for the goats was 26.4 % during the study. The haematocrits were lower in September 2004 (24.7 %) and the months of January to March 2005, with a lowest value of 24.0 % at the end of January 2005. An average haematocrit above 28.0 % was measured in May and June 2005. Differences in haematocrit between BLOCK and NO-BLOCK groups were generally not of statistical significance. Following the tactical treatment, the mean haematocrit for the F©/TACT animals increased by 1.0 percentage point to 24.4 % (Fig. 3). The means for the NON-F© animals decreased by 0.8 and 2.6 percentage points to 24.4 % and 22.8 % for the NON-F©/TACT and NON-F©/NON-TACT goats, respectively. Differences between these groups were not significant statistically (P = 0.158) and there were no long-term effects of the tactical treatment on haematocrit. The younger goats showed significantly lower haematocrits than the older goats in October and November 2004 and in March and April 2005, but the values were within the normal range of 22–36 % for goats[5].

One goat that had a FAMACHA© score of 2 in September 2004 had a haematocrit of 17 % and was dewormed. All other goats that had haematocrits less than 19 % had been treated as their FAMACHA© scores were 3. No goats were scored as 5 during the entire study. Although the FAMACHA© scores were not analysed by means of the ANOVA, there were no apparent differences in FAMACHA© scores between BLOCK and NO-BLOCK animals; however, the FAMACHA© scores for the F©/TACT group were marginally higher than the scores for the NON-F© groups (Fig. 4). The scores for the younger goats were marginally lower than those of the older goats (data not shown). The paler FAMACHA© scores in the F©/TACT goats were not mirrored by higher egg counts and lower haematocrits in this group when compared with the egg counts and haematocrits for the NON-F©/TACT and NON-F©/NON-TACT groups.

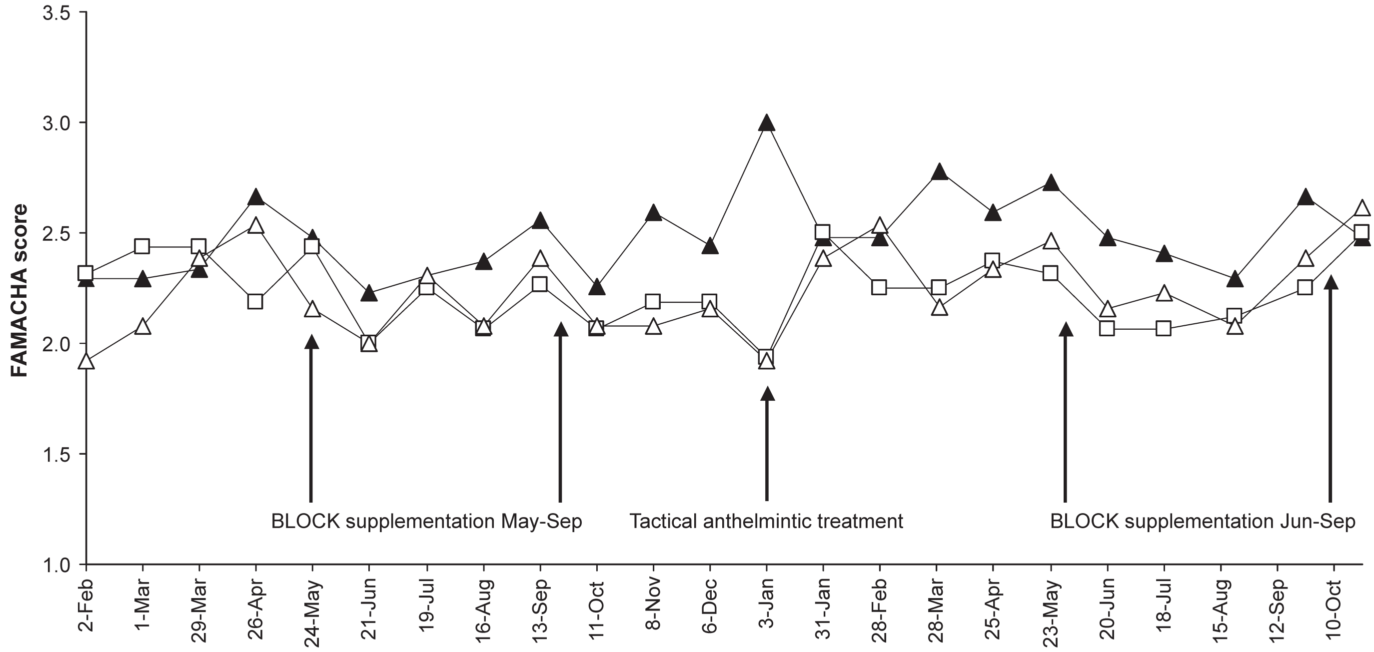

Fig. 4: **The mean FAMACHA© scores for the anaemic-scored** (F©/TACT, ▲) **and non-anaemic-scored** (NON-F©/TACT, △) **groups of goats that were tactically treated with ivermectin and for the non-anaemic-scored group that was not tactically treated** (NON-F©/NON-TACT, □), **Bulwer, South Africa.**

The average body condition scores of the goats varied between 2.0 and 2.5, except for September 2005 when the scores dropped to 1.8. With the exception of a few dates, there were no statistically significant differences between the body condition scores of the various groups (data not shown).

The live weights of the BLOCK animals were almost always lower than those of the NO-BLOCK animals, but this difference was generally not statistically significant. The live weights for the F©/TACT and NON-F© groups were generally similar throughout the study. The younger animals generally had statistically significantly lower live weights than the older animals. The live weights of all the animals decreased by approximately 2.1 kg in September 2004 and August 2005, but the goats recovered this loss in weight during the subsequent 1 to 2 months. At the end of the study the animals had gained an average of 4.0 kg in live weight. Weight gain in BLOCK goats at the end of the study was lower than in NO-BLOCK goats (a difference of 1.8 kg), but was not statistically significant (P = 0.105). The younger animals showed significantly greater weight gains than the older animals (6.3 kg *versus* 2.7 kg; P = 0.003). Both younger and older BLOCK animals showed lower weight gains than their NO-BLOCK counterparts, but the interaction was not significant. The weight gain in the NON-F©/NON-TACT animals (5.9 kg) was higher, but not significantly so, than the weight gain in the F©/TACT (3.2 kg) and NON-F©/TACT (2.9 kg) groups (Fig. 5). The interaction between age and tactical treatment on weight gain at the

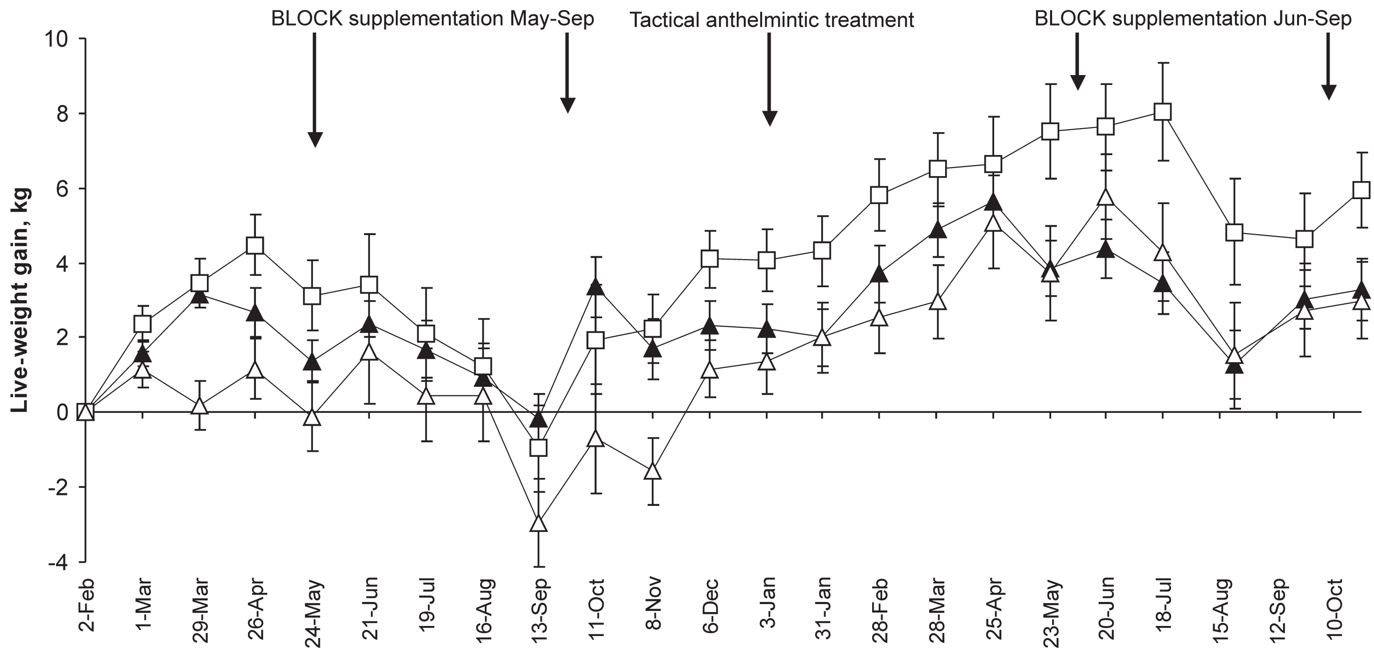

Fig. 5: **The mean live-weight gains for the anaemic-scored, tactically treated group** (F©/TACT, ▲)**, the non-anaemic-scored, tactically treated group** (NON-F©/TACT, △) **and the non-anaemic-scored, not tactically treated group** (NON-F©/NON-TACT, □) **of the communally grazed indigenous goats, Bulwer, South Africa.**

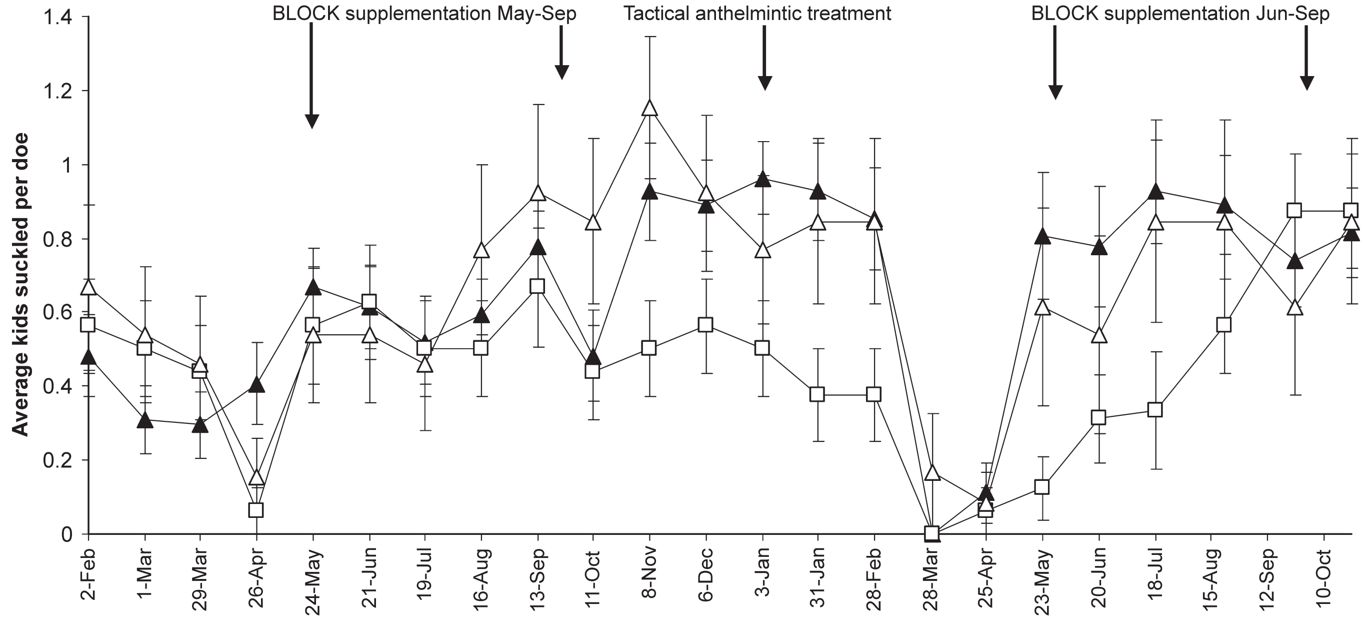

Fig. 6: **The kids suckled per doe by visit date for the anaemic-scored, tactically treated group** (F©/TACT, ▲)**, the non-anaemic-scored, tactically treated group** (NON-F©/TACT, △) **and the non-anaemic-scored, not tactically treated group** (NON-F©/NON-TACT, □) **of the communally grazed indigenous goats, Bulwer, South Africa.**

end of the study was not significant.

There appeared to be a yearly cycle in the kids suckled per doe, with the number of kids suckled per doe decreasing in March and April (Fig. 6). It was therefore considered appropriate to compare the differences in the numbers of kids suckled per doe year-on-year for 2004 and 2005. The differences were determined by subtracting the number of kids suckled by a doe for a particular sample date in 2004 from the number of kids suckled by that doe on the corresponding date in the subsequent year. This was determined for the months of February to October and the average difference year-on-year per doe per group is presented in Fig. 7a–c.

The overall average difference in kids suckled per doe year-on-year was 0.058. The difference in the kids suckled per doe in the younger goats was 0.178, while the difference for the older goats was –0.009. Within the treatment groups, the same trend was evident, with younger goats showing greater increases in kids suckled per doe than the older goats. Overall, urea-molasses block supplementation did not appear to improve the number of kids suckled per doe. In the F©/TACT and NON-F©/TACT goats there was a trend towards an increase in the number of kids suckled (0.170 and 0.088 kids suckled per doe year-on-year, respectively). In the NON-F©/NON-TACT goats, there was no improvement in the number of kids suckled over the course of the study (–0.131 kids suckled per doe year-on-year). None of the differences in kids suckled per doe year-on-year between age groups and between treatment groups were statistically significant ($P > 0.05$).

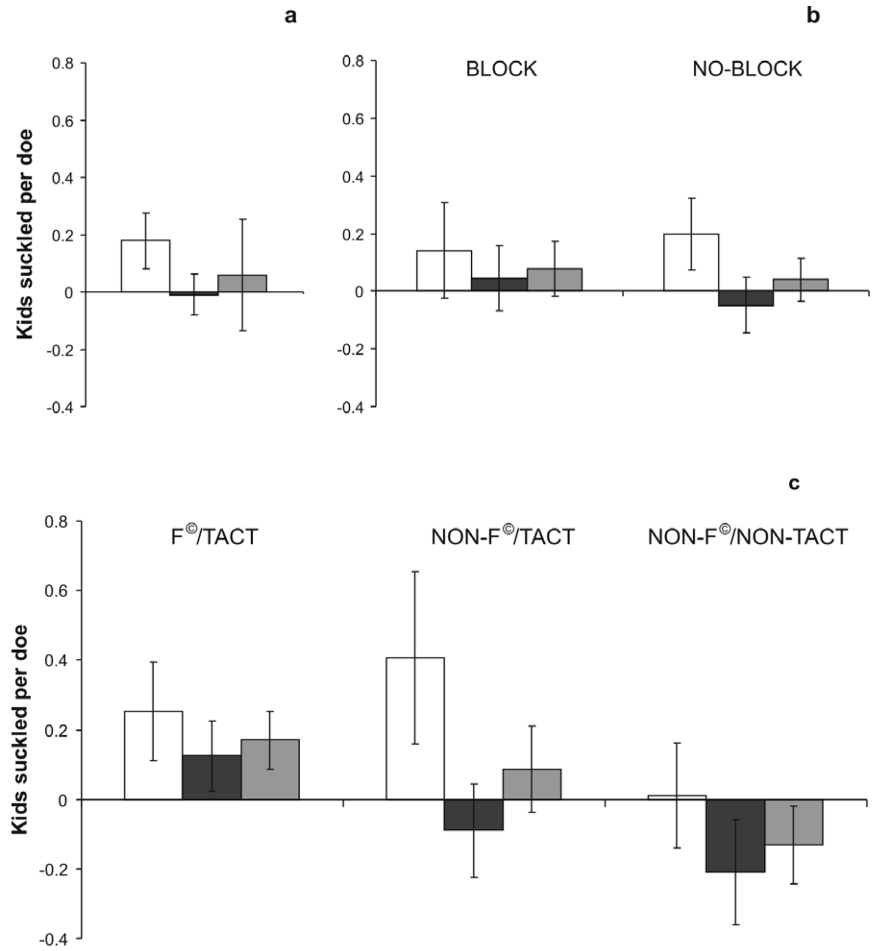

Fig. 7: **The average difference in the number of kids suckled per doe year-on-year** (2004/2005) **for the communally grazed indigenous goats.** a: **The difference in the number of kids suckled per doe** (light-grey columns) **overall as well as the difference between the number of kids suckled per doe for the younger** (white columns) ***versus*** **the older goats** (dark-grey columns)**.** b: **The difference between the number of kids suckled per doe for urea-molasses supplemented** (BLOCK) ***versus*** **non-supplemented** (NO-BLOCK) **goats.** c: **The difference between the number of kids suckled per doe for the anaemic-scored, tactically treated group** (F©/TACT)**, the non-anaemic-scored, tactically treated group** (NON-F©/TACT) **and the non-anaemic-scored, not tactically treated group** (NON-F©/NON-TACT)**.**

DISCUSSION

On-station supplementation of extensively grazed Boer goats with urea-molasses blocks, during the dry winter season in the summer rainfall region at Onderstepoort, without tactical anthelmintic treatment in the wet summer season, resulted in greater carcase values over controls[18] even though intake of block was also low in this experiment (77–78g per goat per day, unpublished data). However, mean faecal nematode egg counts for the goats were low (less than 400 eggs per gram of faeces, epg) throughout the period of this study. It was decided to test the tactical anthelmintic treatment on-farm as the egg counts were expected to be higher. This was the case in the present study, with a period of higher egg counts observed during January to March and mean faecal egg counts calculated for all animals peaking at 2227 epg and 1605 epg in March 2004 and January 2005, respectively. The predominant nematodes in the goats were *Haemonchus* spp. and this would account for the decrease in the haematocrits observed during the months of January to March 2005.

For the purposes of this investigation, the pasture infectivity levels were assumed to be similar between the 3 communities and between communal grazing areas within those communities themselves. The pastures in the communities have similar geographical features such as hills, streams and open pastures; the pastures were subjected to similar weather conditions; they were similarly utilised for grazing, being criss-crossed by sheep, goats, cattle and horses of the community; the ages, breeds and numbers of animals on the pastures appeared to be similar and anthelmintics were used sparingly in the animals, as far as could be determined.

In the absence of data on the age of maturity in the indigenous Zulu goats raised on communal pastures, the division of the goats into younger and older animal groups was somewhat arbitrary. It was reasoned that the animals may take up to 2 years to mature which would correspond with animals with 4 permanent incisor teeth[12]. The only statistically significant differences between the younger goats and the older goats in terms of the parameters measured were seen in live weight and live-weight gain. The younger goats generally had lower live weights than the older goats and they showed a greater weight gain than the older goats, as they were still growing. Though not statistically significant, the egg counts of the younger animals were higher during January and February 2005 than the counts of the older animals. The difference in number of kids suckled per doe year-on-year was greater in the younger animals than in the does with more than 4 permanent incisor teeth, though this difference was not statistically significant. This may have happened because a proportion of the younger animals may not have reached reproductive maturity to produce a kid during the 1st year of the study, creating the greater difference seen year-on-year.

During the dry season, the nutritional status of the natural grazing decreased. This was reflected in a higher dry matter content and lower crude protein content of the herbage, and by a decrease in the live weight, body condition score and haematocrits of the goats during the dry season. Supplementation with urea-molasses blocks during the dry winter season may then have been expected to have a positive effect on production parameters such as live weight, live-weight gain, body condition and the numbers of kids suckled per doe, as well as on the health of the animals as measured by faecal nematode egg count, haematocrit and FAMACHA© score. In the current study, the effects of the supplementation were equivocal. BLOCK and NO-BLOCK animals generally did not show statistically significant differences in body condition scores, live weights, live-weight gain, differences in kids suckled per doe year-on-year and haematocrits. FAMACHA© scores between the 2 groups did not differ.

Supplementation did appear to have an effect on reducing the faecal egg counts in the period immediately following and during the wet period following the 1st year's supplementation ($P < 0.05$), especially in the younger animals. Datta *et al.*[6] have described the long-term effects on resistance to nematode infection and live-weight gain of the short-term provision of protein-enriched diets to weaner sheep.

The consumption of the urea-molasses blocks was low. The manufacturer recommends 100–140 g per sheep per day (Voermol Pasture Supplements Product Handbook, 2nd edition, Voermol, Maidstone, South Africa). Greater effects of the supplementation may have been seen had the consumption of the blocks been higher. The reason for the relatively low consumption of the blocks is not known.

The separation of the animals into F©/TACT and NON-F© groups based on their FAMACHA© scores in January 2005 was justified as the F©/TACT goats had consistently higher FAMACHA© scores than the NON-F© animals (Fig. 4). The FAMACHA© system in goats using a cut-off for treatment of 3 has been shown to have a relatively high sensitivity, but low specificity[8,21], which means that there are a relatively large number of goats that are scored as 3, 4 or 5 but which are in fact not anaemic on haematocrit reading (false positives) and are therefore unnecessarily treated. This probably explains why the mean haematocrits for the F©/TACT group and NON-F© groups were generally within the same range (Fig. 3). This is not a problem as such, since additional anthelmintic treatments to non-anaemic animals are not harmful and may actually be beneficial if those animals are harbouring subclinical nematode infections.

Tactical anthelmintic treatment was apparently effective in reducing the peak in faecal egg counts in the TACT goats at the end of January 2005 ($P = 0.066$) when compared with the NON-F©/NON-TACT animals. Tactical treatment generally had no statistically significant effect on body condition score, live weight, live-weight gain, difference in kids suckled per doe year-on-year and haematocrit.

The results of the supplementation of the goats with urea-molasses blocks were equivocal; while the urea-molasses supplementation appeared to reduce the faecal egg counts immediately following the 2004 supplementation ($P < 0.05$), this did not hold true in 2005. This may have been a result of the relatively low consumption of blocks overall.

Tactical anthelmintic treatment of goats should be recommended in late December or early January given the apparent effectiveness of this treatment in reducing the faecal egg counts when administered before the expected peak in egg counts. Also, the treatment would act as a hedge against losses in those years when there may be a higher challenge than that recorded during the present study.

The resource-poor goat farmers of southwestern KwaZulu-Natal Province, South Africa, had identified poor reproductive performance in their herds as one of their major problems. Any improvements in the number of kids suckled per doe would therefore be of benefit to the farmers. Though not statistically significant, the number of kids suckled per doe year-on-year was higher in the F©/TACT group overall (Fig. 7c) than in the NON-F© groups. This indicates that the symptomatic treatments may be beneficial in themselves, *i.e.* irrespective of whether tactical anthelmintic treatments are applied or not. The animals in the F©/TACT group were treated more frequently than the goats in the other 2 groups. Each doe in the F©/TACT group received on average 12.6 anthelmintic treatments as opposed to 7.9 in the NON-F©/TACT group and 7.4 in the NON-F©/NON-TACT group. There is also evidence to suggest that the use of a salvage approach to treatment for gastrointestinal nematodes is acceptable to resource-poor farmers in southern Africa[9]. Therefore, further investigations into the potential specific effects of the symptomatic treatment of anaemic goats may be of significant benefit.

ACKNOWLEDGEMENTS

This article is an output from Project R8151 funded by the Animal Health Programme, UK Government Department for International Development (DFID), for the benefit of developing countries. The project was also supported financially by a DFID British Council Higher Education Link between the University of Edinburgh and the University of Pretoria (JHB/17/2003) as well as the Royal Society (UK)/National Research Foundation (South Africa) Science Networking agreement. Any opinions, findings, conclusions or recommendations expressed in this article are those of the authors and not necessarily those of the organisations involved, which do not accept any liability in regard thereto. The South African Weather Service is acknowledged for supplying the rainfall and temperature data. The authors gratefully acknowledge the assistance of Messrs D. Chipana and F. Masubelle of Onderstepoort Veterinary Institute. From the Department of Agriculture and Environmental Affairs, KwaZulu-Natal Province, Ms B. Cele and Messrs. O. Howison, J. Nzimande and S. Thusi are thanked for help with field work and Ms L. Thurtell and staff of the Cedara Feed Laboratory for help with feed analysis. Professor F. Rijkenberg of the University of KwaZulu-Natal is thanked for useful comments on the manuscript.

REFERENCES

1. AOAC 1980 *Official methods of analysis* (13th edn). Association of Official Analytical Chemists, Washington, DC
2. AOAC 2002 *Official methods of analysis* (17th edn). Association of Official Analytical Chemists, Washington, DC
3. Bath G F, Hansen J W, Krecek R C, Van Wyk J A, Vatta A F 2001 *Sustainable approaches for managing haemonchosis in sheep and goats. Final report of FAO Technical Co-operation Project in South Africa.* Food and Agriculture Organization of the United Nations, Rome
4. Camp K G T 1997 *The bioresource groups of KwaZulu-Natal. Cedara Report No. N/A/97/6.* Natural Resource Section, KwaZulu-Natal Department of Agriculture, Pietermaritzburg, South Africa
5. Cebra C, Cebra M 2002 Diseases of the hematologic, immunologic, and lymphatic systems (multisystem diseases). In Pugh D G (ed.) *Sheep and goat medicine* (1st edn). Saunders, Philadelphia: 359–391
6. Datta F U, Nolan J V, Rowe J B, Gray G D, Crook B J 1999 Long-term effects of short-term provision of protein-enriched diets on resistance to nematode infection, and liveweight gain and wool growth in sheep. *International Journal for Parasitology* 29: 479–488
7. De Villiers J F, Letty B A 2001 *Information collected during the diagnostic phase in the Nkwezela Sub-Ward, Hlanganani District. KZN Agri Report N/A/2001/68.* Farming Systems Research Section, KwaZulu-Natal Department of Agriculture and Environmental Affairs, Hilton, South Africa
8. Kaplan R M, Burke J M, Terrill T H, Miller J E, Getz W R, Mobini S, Valencia E, Williams M J, Williamson L H, Larsen M, Vatta A F 2004 Validation of the FAMACHA© eye color chart for detecting clinical anemia in sheep and goats on farms in the southern United States. *Veterinary Parasitology* 123: 105–120
9. Kumba F F 2004 Gastrointestinal worm control in small ruminants on communal farms in the east of Namibia: evidence of effectiveness of the traditional salvage approach. *Bulletin of Animal Health and Production in Africa* 52: 71–78
10. Malan F S, Van Wyk J A, Wessels C D 2001 Clinical evaluation of anaemia in sheep: early trials. *Onderstepoort Journal of Veterinary Research* 68: 165–174
11. Malan F S, Visser P S 1993 Faecal egg counts by a new method using tube filters. *Abstracts: 14th International Conference of the World Association for the Advancement of Veterinary Parasitology, Cambridge, UK*, 8–13 August 1993: 328
12. Mitchell T 1982 *How to tell the age of goats. Agfact A7.2.2* (1st edn). Department of Agriculture New South Wales, Australia
13. Reinecke R K 1983 *Veterinary helminthology.* Butterworths, Durban
14. Russell A 1984 Body condition scoring of sheep. *In Practice* 6: 91–93
15. Van Schalkwyk P C, Schröder J, Malan F S, Van Wyk J A 1995 *Worm workshop recommendations on worm control* (1st revision). Division of Helminthology, Onderstepoort Veterinary Institute, Pretoria
16. Van Soest P J, Robertson J B 1980 Systems of analysis for evaluating fibrous feeds. In Pigden W J, Balch C C, Graham M (eds) *Standardization of analytical methodology for feeds: proceedings of a workshop held in Ottawa, Canada, 12–14 March 1979.* International Development Research Centre, Ottawa
17. Van Wyk J A, Cabaret J, Michael L M 2004 Morphological identification of nematode larvae of small ruminants and cattle simplified. *Veterinary Parasitology* 119: 277–306
18. Vatta A F, Harrison L J S, Krecek R C, Pearson R A 2005 Relative economic benefits of strategic anthelmintic treatment and urea-molasses block supplementation of Boer goats raised under extensive grazing conditions at Onderstepoort, Pretoria, South Africa. In Smith T, Godfrey S H, Buttery P J, Ssewannyana E, Owen E (eds) *Small stock in development. Proceedings of a workshop on enhancing the contribution of small livestock to the livelihoods of resource-poor communities. Hotel Brovad, Masaka, Uganda, 15–19 November 2004.* Natural Resources International Ltd., Aylesford, Kent, UK
19. Vatta A F, Krecek R C, Letty B A, Van der Linde M J, Grimbeek R J, De Villiers J F, Motswatswe P W, Molebiemang G S, Boshoff H M, Hansen J W 2002 Incidence of *Haemonchus* spp. and effect on haematocrit and eye colour in goats farmed under resource-poor conditions in South Africa. *Veterinary Parasitology* 103: 119–131
20. Vatta A F, Krecek R C, Letty B A, Van der Linde M J, Motswatswe P W, Hansen J W 2002 Effect of nematode burden as assessed by means of faecal egg counts on body condition in goats farmed under resource-poor conditions in South Africa. *Veterinary Parasitology* 108: 247–254
21. Vatta A F, Letty B A, Van der Linde M J, Van Wijk E F, Hansen J W, Krecek R C 2001 Testing for clinical anaemia caused by *Haemonchus* spp. in goats farmed under resource-poor conditions in South Africa using an eye colour chart developed for sheep. *Veterinary Parasitology* 99: 1–14
22. Williams C S F 1990 Routine sheep and goat procedures. *Veterinary Clinics of North America: Food Animal Practice* 6: 737–758