Effect of Work Stress and Supplementary Feeding on Body Conformation, Ovarian Activity and Blood Parameters in Mashona Cows in a Smallholder Farming System[a]

M. Chimonyo[1], N. T. Kusina*, H. Hamudikuwanda and O. Nyoni
Department of Animal Science, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe

ABSTRACT : The objective of this study was to determine the effect of draught stress on certain haemograms and ovarian activity and the influence of dietary supplementation on the negative effects of draught in cows. Blood parameters and ovarian activity were assessed in supplemented non-working (SNW), supplemented working (SW) and non-supplemented non-working (NSNW) cows. Body weights and body condition scores were recorded fortnightly. Blood samples were collected through jugular venipuncture in December, February and April to determine the contents of haematocrit, erythrocyte, haemoglobin and white blood cells. Ovarian palpations were carried out in October, January and April. The SW cows maintained body weights ($p>0.05$) during the monitoring period whereas both SNW and NSNW cows gained ($p<0.05$) body weights. Body condition scores were similar between SW and NSNW cows. Cows in the NSNW group had lower ($p<0.05$) haematocrit concentrations in April than both supplemented groups. In December, erythrocyte concentrations were similar ($p>0.05$) among all treatment groups. Haemoglobin concentrations were higher ($p<0.05$) in SW and SNW cows in February and April than in December. The SW cows had higher leucocyte contents ($p<0.05$) in February than the other groups of cows. All treatment groups showed similar ($p>0.05$) ovarian activity in January. However, the NSNW group showed a lower proportion ($p<0.05$) of cows that exhibited normal ovarian activity in April. The results suggest that dietary supplementation of cows increases haematocrit and haemoglobin contents. In addition, supplementary feeding during the period of draught power provision maintains ovarian activity in cows. (*Asian-Aus. J. Anim. Sci. 2000. Vol. 13, No. 8 : 1054-1058*)

Key Words : Draught Cows, Dietary Supplementation, Haemograms, Ovarian Activity

INTRODUCTION

It has long been realised that draught animal technology improves the quality of rural life in developing countries (Starkey, 1994). One of the major limitations to farm productivity in many rural areas of Zimbabwe and tropical sub-Saharan Africa is the shortage of draught animals. The occurrence of recurrent droughts has markedly decimated herd sizes, including oxen, which are the preferred source of draught power. Since many smallholder farmers cannot afford the cost of tractors, they have resorted to using cows as draught animals (Chimonyo et al., 1999).

Ideally, sound management of draught animals throughout the year is required for increased production (Fall et al., 1997). The opportunity cost, on an annual basis, of supporting draught oxen, is considerable because the animals are utilised for short periods. Furthermore, oxen compete with cows for limited feed resources (Ndlovu and Francis, 1997). The cow is "bi-potential" in that it provides draught power, and if properly managed, a calf and milk. Thus, although communal farmers use cows for draught out of desperation, it is also logical and economical.

In an earlier study (Chimonyo et al., 1999), draught cows which were not supplemented lost 12% of their body weights, and their ovarian activity was depressed during the period from November to February. Thereafter, body weights increased until June. The physiological changes associated with stress, especially blood parameters, were not monitored to determine the effects of work stress in draught cows. The objective of this study was, therefore, to determine whether dietary supplementation with a mixture of veld hay and sunflower cake could reverse the negative effects of draught (work) stress on ovarian activity in cows. In addition, changes in the concentrations of blood parameters, associated with stress, were determined.

MATERIALS AND METHODS

Site description

A detailed site description was presented in an earlier paper (Chimonyo et al., 1999). Briefly, the study was conducted in a semi-arid, crop-livestock communal (smallholder) farming area of Sanyati

* Address reprint request to N. T. Kusina. Tel: +263-4-303211, Fax: +263-4-333407, E-mail: kusina@ancsi.uz.zw.
[1] Present Address: Department of Paraclinical Veterinary Studies, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe.
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District, Kadoma, Zimbabwe from November 1998 to April 1999. The site lies at 29°S and 19°E and is 900-1200 metres above sea level. It receives an annual rainfall of 450-600 mm, mainly during the rainy season extending from November to March. Mean diurnal temperatures experienced in Sanyati are 32℃ in the hot dry season (August to October), and 24℃ from May to July. Ambient temperatures during the experimental period averaged 17℃ in the morning and 31℃ in the afternoon. During the rainy season, pastures are abundant and of good quality. Common pasture grasses in this area are *Setaria pallidefusca, Sporobolus panicoides* and *Aristida rhiniochloa*.

Experimental treatments and animals

Forty-eight non-pregnant multiparous indigenous Mashona cows (mean body weight 271±14.2 kg) were selected from 24 households. The cows were confirmed to be non-pregnant through ovarian palpations. The animals were randomly allocated into one of three treatment combinations that comprised supplemented working (SW), supplemented non-working (SNW) and non-supplemented non-working (NSNW) groups.

All cows receiving supplementary feed were individually fed 3 kg of ram-pressed sunflower cake and 1 kg of chopped maize stover every day, whereas NSNW cows relied on natural pasture only. The estimated stocking rate was four hectares per livestock unit. The chemical composition of the supplementary diet is shown in table 1. Working cows were used in mixed spans, i.e., they were paired with oxen.

Table 1. Ingredients (g/kg) and chemical composition (g/kg DM) of the supplementary feed given to the cows

Ingredients	Grams per kg DM
Sunflower cake	750
Veld hay	250
Chemical composition	
Dry matter (DM)	947.3
Organic matter (OM)	905.8
Crude protein (CP)	161.8
Ether extracts (EE)	224.3
Neutral detergent fibre (NDF)	393.3
Acid detergent fibre (ADF)	335.3
Metabolisable energy (MJ/kg)	11.03

The main draught provision activities were ploughing, ridging and weeding (November to February) and transportation of harvested produce to storage silos or marketing depots between March and April. During the period of ploughing, draught cows worked on average four hours in the morning (from 0600 to 1000 h) and two hours in the afternoon (from 1500 to 1700 h). The average ploughing speed was 0.06 ha per hour. All the cows monitored were penned at night.

Measurements

1) Body weights and body condition scores

Cows were weighed at two-week intervals using a cattle scale (Cattleway, Marondera, Zimbabwe). Body conditions were scored concurrently with body weight measurements using a 5-point scale (Van Niekerk and Louw, 1980). The areas that were assessed were at the tail head, loin, ribs and the backbone.

2) Ovarian palpations and pregnancy diagnosis

Ovarian activity and pregnancy status of the cows were assessed through rectal palpation. Cows that had corpora lutea present were considered to be showing ovarian activity. The assessments were first carried out in October 1998 to eliminate cows which were already pregnant. The assessment of ovarian function and pregnancy status was also done in January and April 1999.

3) Blood parameters

Blood samples were collected by jugular venipuncture in December 1998, February and April 1999. The samples were collected at around 0630 hours and analysed for haematocrit, erythrocyte, haemoglobin and leucocyte content within 24 hours after collection. The blood parameters were analysed using a Coulter® T-890 Blood Analyser (Coulter Electronic Products, Luton, England).

4) Statistical analyses

Data from four and three cows from the SNW and NSNW groups, respectively, that had missing records for ovarian status were discarded. Data presented in this report was therefore obtained from 16 SW, 12 SNW and 13 NSNW cows. The PROC MIXED procedure of SAS (SAS, 1994) for repeated measures analysis, as described by Littell et al. (1998), was used to determine the effects of diet and work stress on body weight, body condition scores and blood parameters. The model used was:

$$Y_{ijkl}=\mu+D_i+W_j+M_k+(D\times M)_{ik}+(W\times M)_{jk}+C(W_j)+E_{ijkl};$$

where:

Y_{ijkl} =response variable (body weight, body condition, blood parameters)

μ =population mean

D_i =fixed effect of diet (i=1, 2)

W_j =fixed effect of work (i=1, 2)

M_k =fixed effect of time (month of monitoring) (j=1, 2, 3)

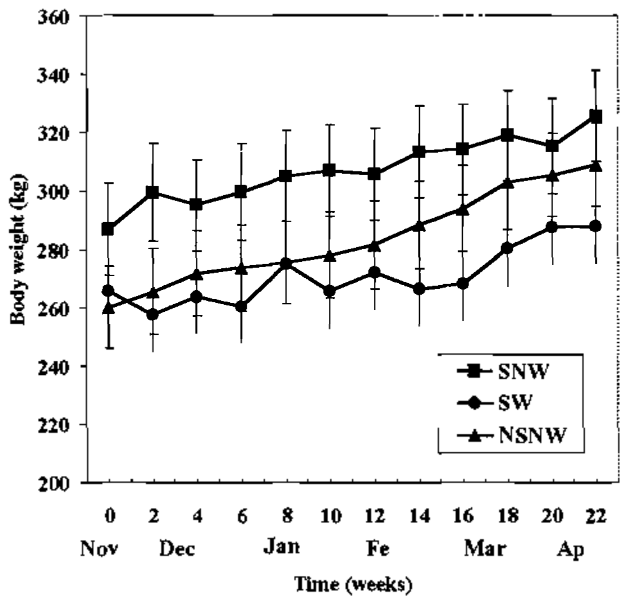

Figure 1. Changes in body weights in supplemented non-working (SNW), supplemented working (SW) and non-supplemented non-working (NSNW) cows from November 1998 to April 1999

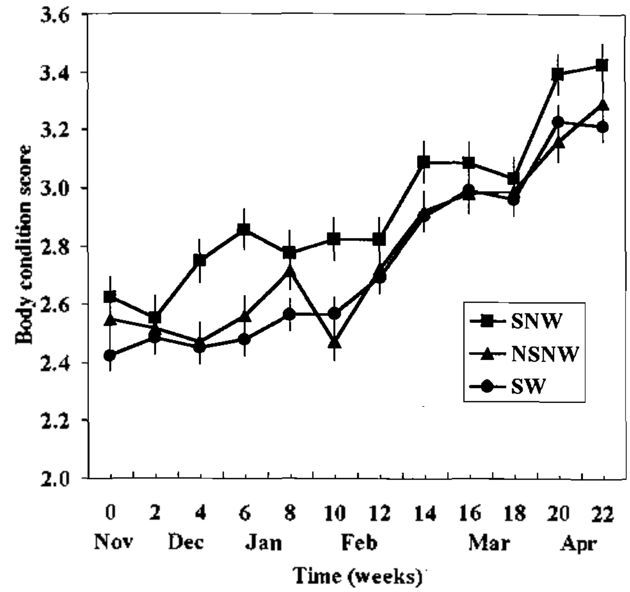

Figure 2. Changes in body condition scores in supplemented non-working (SNW), supplemented working (SW) and non-supplemented non-working (NSNW) cows from November 1998 to April 1999

Table 2. Proportion (%) of cows showing ovarian cyclicity in supplemented non-working (SNW), supplemented working (SW) and non-supplemented non-working (NSNW) cows in January and April, 1999

Treatment group	Number of cows	January	April
SW	16	62.5 (10)[a,1]	75 (12)[a]
SNW	12	75 (9)[a]	100 (12)[a]
NSNW	13	76.9 (10)[a]	53.9 (7)[b]

[a,b] Values within the same column with different superscripts differ ($p<0.05$).
[1] Figures in parentheses denote number of cows that were cycling.

$(D\times M)_{ik}$ =diet × time period of work interaction
$(W\times M)_{jk}$ =work × time period of work interaction
$C(W_i)$ =random effect of cow in the i^{th} work group
E_{ijkl} =random error

Square root transformations were performed on body condition scores before they were analysed using the same model as used for body weight measurements. The numbers of cows showing ovarian activity were compared by the 2-test using the PROC FREQ procedure of the Statistical Analysis System package (SAS, 1994).

RESULTS

Changes in body weights and body condition scores

As shown in figure 1, the SW cows maintained body weights ($p>0.05$) during the monitoring period. However, both SNW and NSNW cows gained ($p<0.05$) body weights during this period. The body condition scores in all the experimental cows increased ($p<0.05$) during the trial period (figure 2). Cows in the SNW group had higher ($p<0.05$) body condition scores than SW and NSNW cows, but the scores were similar between SW and NSNW cows.

Ovarian activity

There were no differences ($p>0.05$) in the proportion of cows showing ovarian activity among all the treatment groups in January (table 2). However, NSNW cows showed a lower proportion ($p<0.05$) of cows that exhibited normal ovarian activity in April. The SNW and NSNW groups had one cow each that conceived during the experimental period.

Blood parameters

The contents of haematocrit, erythrocytes, haemoglobin and leucocytes in the blood of the cows are shown in table 3. There were no differences ($p>0.05$) in haematocrit content except the lower ($p<0.05$) concentrations observed in NSNW cows in April than in SW and SNW cows. In December, there were no significant differences ($p>0.05$) in erythrocyte concentrations among all treatment groups. Supplemented working cows showed a higher ($p<0.05$) erythrocyte concentration during February than the other two groups of cows. There was a higher erythrocyte concentration in supplemented than NSNW cows in April. Haemoglobin concentrations were higher ($p<0.05$)

Table 3. Contents of haematocrit, erythrocytes, haemoglobin and leucocytes in blood of supplemented non-working (SNW), supplemented working (SW) and non-supplemented non-working (NSNW) cows

Parameter	Treatment combination	December	February	April
Haematocrit (%)	SNW	27.4 ± 1.69[a]	29.5 ± 1.05[a]	30.5 ± 1.26[b]
	SW	28.3 ± 1.05[a]	31.1 ± 0.97[a]	29.3 ± 1.00[b]
	NSNW	27.1 ± 1.33[a]	27.4 ± 1.69[a]	24.6 ± 1.54[a]
Erythrocytes ($\times 10^{12}$/L)	SNW	5.6 ± 0.37[a]	5.93 ± 0.23[a]	6.2 ± 0.27[b]
	SW	5.7 ± 0.23[a]	6.2 ± 0.21[b]	6.1 ± 0.22[b]
	NSNW	5.3 ± 0.29[a]	5.1 ± 0.37[a]	5.0 ± 0.33[a]
Haemoglobin (g/dL)	SNW	8.9 ± 0.59[1a]	10.5 ± 0.37[2b]	10.5 ± 0.44[2b]
	SW	9.2 ± 0.37[1a]	10.7 ± 0.34[2b]	9.9 ± 0.36[2b]
	NSNW	8.9 ± 0.47[1a]	9.2 ± 0.59[1a]	8.1 ± 0.54[1a]
Leucocytes ($\times 10^{9}$/L)	SNW	9.6 ± 1.18[a]	11.6 ± 1.50[a]	12.5 ± 1.37[a]
	SW	12.0 ± 1.50[a]	16.2 ± 0.87[b]	13.2 ± 1.12[a]
	NSNW	10.2 ± 0.93[a]	14.1 ± 0.93[a]	15.3 ± 0.89[a]

[a,b] Values within the same column for each parameter with different superscripts differ ($p<0.05$).
[1,2] Values with different superscripts in a row indicate a statistical difference ($p<0.05$).

in SW and SNW cows in February and April than in December. Cows in the SW group had higher concentrations ($p<0.05$) of leucocytes in February than the other groups of cows, but there were no differences ($p>0.05$) in December and April. Within treatment groups, there were no differences ($p>0.05$) in concentrations of haematocrit, erythrocytes and leucocytes with time, except for haemoglobin concentrations.

DISCUSSION

The increase in body weights in NSNW cows from November to April indicates that natural pasture during the rainy season was adequate to meet maintenance energy and protein requirements of cows as described earlier (Chimonyo et al., 1999). This is because during this period grasses will be palatable and contain crude protein (CP) levels in excess of 12%, unlike during the dry season when CP could be less than 3% (Topps, 1977). In an earlier study (Chimonyo et al., 1999), cows used for draught provision lost body weight from May to January. In contrast, cows not used for draught regained weight starting October until May. In the current study, cows provided with supplementary feed maintained body weights and gained body condition during the time of intense draught activity (November to February).

The higher content of erythrocytes in SW cows during February agrees with results reported by Apple et al. (1994) that showed that exercise causes the spleen of sheep to contract and discharge erythrocytes into the circulation. The spleen is an important reservoir of erythrocytes. These erythrocytes can be released when the body tissues have a greater demand for oxygen. The increases are critical mechanisms enabling ruminants to increase oxygen transportation to working muscles (Kulmann et al., 1985). It has also been shown that well-trained horses adapt to the high oxygen requirement by having increased total erythrocyte counts (Rose and Allen, 1985). According to Apple et al. (1994), there may be confounding effects of loss of body water due to sweating, causing haemoconcetration. It was observed that the main draught activity around April was transporting produce to the market and the animals could have been deprived of adequate water. The high ambient temperatures at this time of the year could have worsened the dehydration.

The normal values for haematocrit, erythrocytes and haemoglobin concentrations for bovine are 24-38%, 5-9 $\times 10^{12}$/L and 8-14 g/dL, respectively (Doxey, 1983). The results obtained in this experiment fall within the expected ranges. The finding that supplemented cows had high concentrations of haematocrit, erythrocytes and haemoglobin in April suggests that dietary supplementation was more influential in affecting these parameters than draught stress. Our results, however, differ from those reported by Sawadago et al. (1991), who observed no differences in cows that were under an extensive range management system and those that were supplemented with concentrate feeds.

The observation that all supplemented cows showed increased levels of haemoglobin in February and April, whereas the concentrations did not change in NSNW cows is difficult to explain. However, from our results, it is inferred that dietary supplementation has profound effects on some blood parameters, particularly in April. This could be exacerbated by the low rainfall and high ambient temperatures experienced in the area during this time. It was also observed that grasses started to dry up in April and it is probable that their palatability and digestibility were starting to decline. The normal white blood cell concentrations range from 4 to 10×10^9/L (Doxey, 1983). However, the high white blood cell concentration found in SW cows could be attributed to draught stress, which compromised immunity of the cows. Beating of the animals during the course of driving and steering them, as often happened during work, could have inflicted traumatic injury, triggering some immune response.

The similarity, across the treatments, in the proportion of cows exhibiting ovarian activity in January, suggests that dietary supplementation was effective in maintaining normal ovarian activity in working cows. The results confirm our earlier observations (Chimonyo, 1998) and agree with those of Zerbini et al. (1993), who reported similar fertility rates between supplemented cows that were subjected to work stress and those which were not working. It is surprising that from January to April, although a large proportion of cows showed normal ovarian activity, only two cows conceived. The lack of sufficient fertile bulls has been suggested as a major causative factor for low conception rates in the study area (Chimonyo, 1998).

IMPLICATIONS

All the cows had similar ovarian activity in January, indicating that supplementary feeding was effective in maintaining the reproductive performance of cows used for the provision of draught. The haematocrit, erythrocyte and haemoglobin contents obtained were within normal ranges. However, high haematocrit and haemoglobin concentrations were observed in February and April, suggesting that dietary supplementation increases these parameters in working cows. Leucocyte content was higher in draught than non-draught cows, suggesting that the use of cows for draught provision may have compromised their immunity.

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