

Full Length Research Paper

Effect of dry season nutritional supplementation on fertility in bulls in Sanyati smallholder farming area, Zimbabwe

U. Marume^{1*}, N.T. Kusina², H. Hamudikuwanda², M. Ndengu³ and O. Nyoni²

¹Department of Agriculture, Faculty of Science, Zimbabwe Open University, P. O. Box MP 1119, Mt. Pleasant, Harare, Zimbabwe.

²Department of Animal Science, Faculty of Agriculture, University of Zimbabwe, P. O. Box MP 167, Mt. Pleasant, Harare, Zimbabwe.

³Department of Paraclinical Veterinary Science, Faculty of Veterinary Studies, University of Zimbabwe, P. O. Box MP 167, Mt. Pleasant, Harare, Zimbabwe.

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Twelve indigenous bulls, allocated to two groups comprising six bulls each, were used in the study to determine the effect of dry season nutritional supplementation on scrotal circumference and semen characteristics. One group was supplemented with silage while the other acted as the control. Soundness evaluations were conducted in October, December and February. Breeding efficiency of bulls was measured by pregnancy rates. Month and nutrition significantly affected body condition and body weights in both groups ($P < 0.05$). Mean scrotal circumference was significantly higher ($P > 0.05$) for the supplemented bulls than the control group in October (36.3 ± 1.5 versus 32.0 ± 2.6 cm). Nutrition and month of collection did not affect scrotal circumference and semen characteristics in both groups ($P > 0.05$). There were no significant differences in sperm motility between the two groups. Sperm concentration was higher in the control group in all months of collection ($P < 0.05$). Body condition scores and body weights of cows increased initially but declined to a minimum in December (2.9 ± 0.34 ; 298 ± 15 kg, respectively). Highest mean pregnancy rate (42%) was recorded in Jese village in October while the lowest (13%) was recorded in Makomo village during the same month. It was concluded that supplementary feed did not influence semen characteristics and reproductive capacity of the bulls.

Key words: Bull, nutrition, scrotal circumference, semen, breeding soundness evaluation, pregnancy rate, ovarian activity.

INTRODUCTION

Previous work from our research team provided empirical evidence supporting the hypothesis that bull scarcity and poor semen quality might have accounted for observed low overall cowherd conception and pregnancy in Sanyati communal area. This observation was supported by earlier research findings published in a literature from the

same site reporting that, despite the observation, cows provided access to supplemental feeding and exhibited normal cyclicity throughout the year; conception rate in the cowherd remained low approximating 27% (Chimonyo et al., 2000). It was therefore suggested that the problem might be associated with the quality and/or

Table 1. Proximate composition analysis results (%) of supplementary feed on a dry matter basis.

Nutrient	Proportion (%)
DM	87.0
CP	5.0
NDF	63.0
ADF	40.0
EE	12.0
Ca	1.0
P	1.0
Ash	10.0
Energy (MJ/kg)	5.6

scarcity of quality bulls in Sanyati (Chimonyo et al., 2000). Therefore the objective of this study was to assess the fertility of bulls found in Sanyati as a measure to provide an insight into their potential for successful breeding in turn, hopefully improve conception in the cowherd in Sanyati. The hypothesis tested was that, compromise spermatogenesis might have occurred in bulls due to fluctuating nutritional supply.

Nutrition has been reported to influence testicular growth, sperm production capacity and semen quality, particularly in tropical areas where seasonality in quality and quantity of feed is severe (Entiwestle, 1983). In Sanyati, livestock depend on natural pasture for nutritional sustenance, but the vegetation in Sanyati is mainly woodland savanna with little undergrowth. Abundance and quality of natural pasture vary with season. During the rainy season, pastures are abundant and of good quality.

In contrast, during the dry season, grasses are scarce and where available, are unpalatable. It is therefore highly conceivable that livestock, including bulls are likely to suffer from "seasonal" nutritional deficiency leading to loss of body condition and body weight resulting to temporal sub-fertility at certain times of the year. Therefore, the study was designed to investigate the influence of dry season supplementation on body condition, body weight and semen characteristics in bulls in Sanyati. In addition, breeding efficiency of the bulls was assessed.

MATERIALS AND METHODS

Study area

The study was conducted from August 2001 to February 2002 in three adjacent villages, namely Jese, Makomo, and Majoni situated in a semi-arid communal (smallholder) farming area of Sanyati District, Kadoma, Zimbabwe. Sanyati is in Mashonaland West Province and is approximately 250 km from Harare. It is in Natural Region IV of Zimbabwe, an agro ecological region where integrated crop-livestock farming is practised. The area is situated at 29°E and

19°S and is 900 to 1200 m above sea level (Chimonyo et al., 2000). The area has high mean maximum and mean minimum diurnal temperatures of 32°C and 24°C in the hot dry season (August to October) and cold dry months (May to July), respectively. Sanyati receives low annual rainfall (450 to 600 mm) mainly during the rainy season extending from November to March. The area is subject to periodic droughts (Ulrich and Kjaer, 1994). Vegetation in Sanyati is mainly woodland savanna with little undergrowth. The dominant tree species are *Acacia* species and *Colophospermum mopane*. Abundance and quality of natural pasture vary with season. During the rainy season, pastures are abundant and of good quality. In contrast during the dry season, grasses are scarce and where available, are unpalatable. Consequently, animals are then forced to forage on the riverine vegetation, in addition to crop residues left in the fields.

Farmer selection

From a total of 171 households with cattle residing in the three adjacent villages; namely Jesse, Majoni and Makomo, 98 households were selected at random to participate in the study following a preliminary survey of population demography. Selection was based on accessibility and farmer willingness to participate.

Animal management

A total of 12 bulls comprising nine local Mashona bulls and their crosses with Brahman from the three villages, selected based on the spot breeding soundness evaluation conducted in August 2001, and three-purchased performance tested Tuli bulls were used in the study. These were allocated into two groups comprising six bulls each. One group acted as the control and did not receive any supplementary feed. The other group consisting of three local bulls and the Tuli bulls were supplemented with 15 kg silage/bull/day (4 kg/bull on a DM basis) as shown in Table 1, from August to November. Collection of data on body condition scores and body weights commenced in September 2001 and was terminated at the end of February 2002. Breeding soundness evaluation of bulls and pregnancy diagnosis of cows in the herds mixing with the bulls were conducted in October, December 2001 and February 2002.

Measurements

Body condition scores: The body condition scores for both the bulls and cows were assessed using the 5-point score (Van Niekerk and Lauw, 1980).

Body weights: The bulls were weighed once a month using cattle weigh scale (Cattleway, Marondera, Zimbabwe). Cows were weighed four times that is, in August, October, December 2001 and February 2002 at the same time when pregnancy diagnoses were conducted.

Breeding soundness evaluation (BSE): Fertility of the 12 bulls was evaluated through the breeding soundness evaluations described by Morrow (1988) according to the Society of Theriogenology's specifications. Briefly, each bull was subjected to a complete examination that comprised physical examination of the entire animal, clinical examination of the testes, and visual and microscopic examination of the testes. Physical examination involved assessment of conformational and structural soundness of the bulls. Further, the eyes, nose and mouth were examined for normality. Reproductive examination assessed reproductive organs and accessory glands for developmental defects and inflammations.

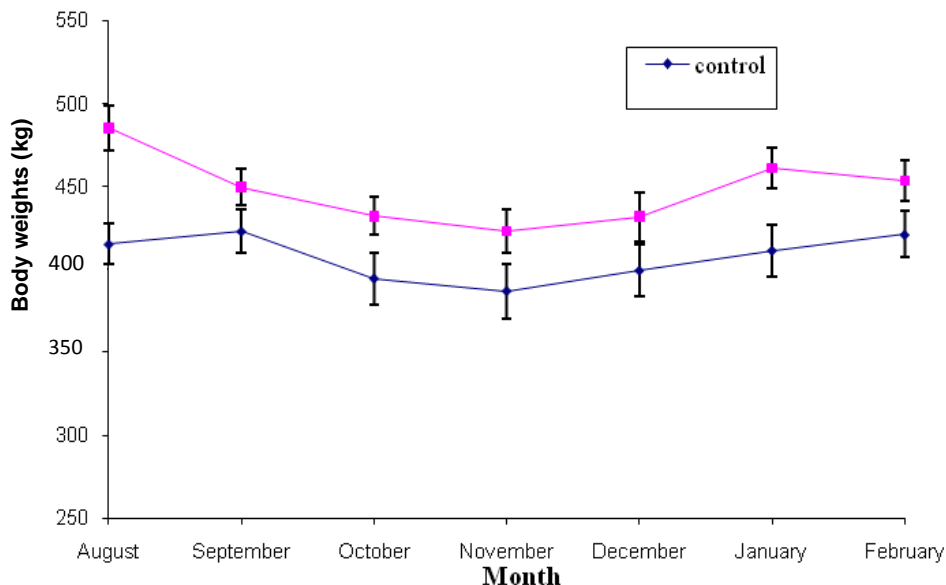


Figure 1. Changes in body weights of bulls in Sanyati smallholder area from August 2001 to September 2002.

Accessory glands were examined through rectal palpation, while the spermatic cord, scrotum, testicles and epididymis were palpated externally. The penis and prepuce were examined during semen collection by electro ejaculation. Scrotal circumference was measured using a measuring tape. Finally, semen samples were collected using an electro ejaculator for examination. The semen was observed under a light microscope at magnification x10 for mass motility and x40 for individual motility while a sperm staining using eosin was used to determine sperm morphology at magnification x100 (Spitzer and Hopkins, 1997). Each bull was awarded a breeding soundness certificate after the evaluation.

Ovarian function and cow fertility

Ovarian activity and pregnancy rates were evaluated through rectal palpation of the uterus and ovaries. Ovarian structures were palpated to determine ovarian cysts, which impair exhibition of normal cyclicity.

Statistical analyses

The Proc Mixed Procedure for repeated measurements of the Statistical Analysis System (SAS, 1998) outlined by Littell and Henry (1998) was used to analyse the effects of supplementary feed and month of assessment on body weight, body condition, scrotal circumference, percentage sperm motility and percent normal sperm. Initial body weight, body condition score and scrotal circumferences were used as covariates in the model. Transformation of data on percent motility and percent normal sperm was done through arcsine-squared root to achieve normality. Model used was as follows:

$$Y_{ijk} = \mu + S_i + M_j + V_k + (S \times M)_{ij} + b(S_i) + E_{ijkl}$$

Where Y_{ijk} = body weight, scrotal circumference, semen volume, sperm motility, sperm concentration and percent normal sperm; μ = overall mean; S_i = fixed effect of treatment group ($i = 1, 2$); M_j = fixed

effect of time (month of assessment); V_k = fixed effect of village ($k = 1, 2, 3$). $(S \times M)_{ij}$ = feed x month interaction; $b(S_i)$ = random effect of bull in the i^{th} treatment group, and E_{ijk} = random error.

RESULTS

Bull fertility

Body condition and body weights

The patterns of changes in body condition score and body weight during the period of study are presented in Figures 1 and 2, respectively. The pattern of changes in the body condition scores and body weight was similar in both groups. There were significant differences ($P < 0.05$) in initial weights between the two groups. Month and nutrition significantly affected body condition score and body weight ($P < 0.05$).

Scrotal circumference

The pattern of changes in scrotal circumferences is shown in Table 2. There were no significant differences in initial scrotal circumference between the two groups ($P < 0.05$). Mean scrotal circumference was significantly higher for the supplemented bulls than the non-supplemented bulls in October ($P < 0.05$). However, there was no significant difference in mean scrotal circumference for both groups in December and February. There was no effect of nutrition on scrotal circumference.

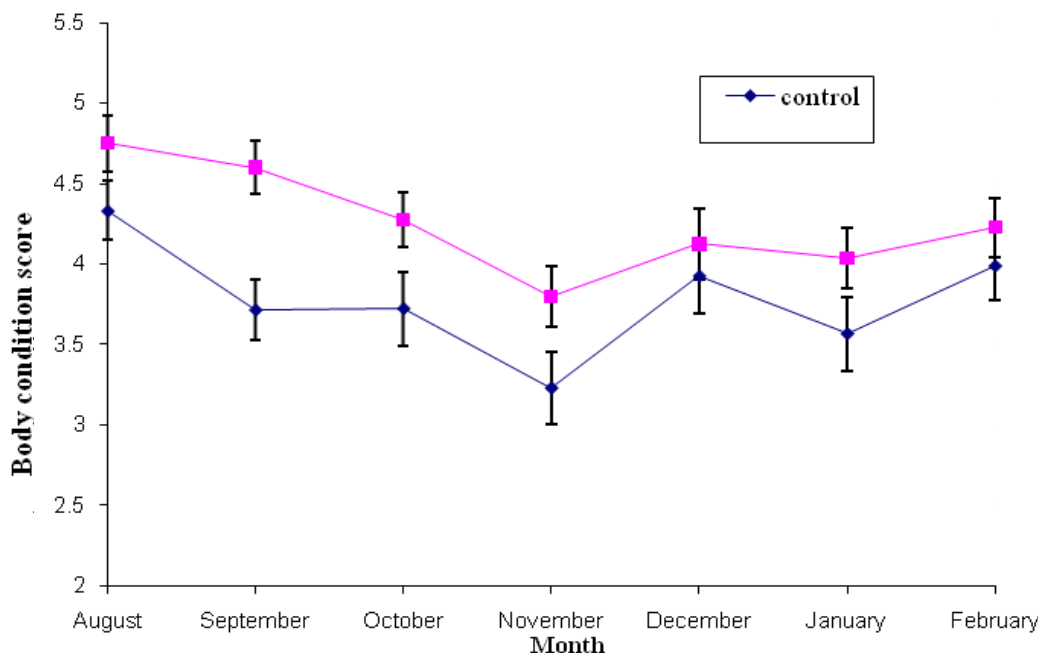


Figure 2. Changes in body condition of bulls in Sanyati smallholder area from August 2001 to September 2002.

Table 2. Mean scrotal circumferences (cm) in October, December 2001 and February 2002 for control and supplemented bulls in three villages in Sanyati Smallholder area.

Month	Control (cm)	Supplemented (cm)	Significance
October (2001)	32 ± 1.5	36.3 ± 2.6	*
December (2001)	35 ± 2.6	35.7 ± 2.6	NS
February (2002)	32.3 ± 1.3	33.8 ± 2.0	NS

* $P < 0.05$; ¹NS, Non-significant.

Semen evaluation

Semen volume was neither influenced by month of collection nor nutrition ($P > 0.05$). Supplemented bulls had higher semen volumes in October and December than the control group ($P < 0.05$). However, in February the control group had significantly higher semen volume than the supplemented group (Figure 3).

Percentage sperm motility was not influenced by both month of semen collection and nutrition ($P > 0.05$). Monthly changes in motility were observed to be small in the two groups. However, percentage motility was highest in December for both the supplemented and non-supplemented bulls, respectively (Figure 4). Month of semen collection and nutrition did not significantly affect sperm concentration ($P < 0.05$). Mean sperm concentration for both the supplemented and non-supplemented was highest in October; intermediate in December and lowest in February (Figure 5). In October,

sperm concentration was almost as twice as much in control group as in supplemented group (6.18×10^6 versus 3.79×10^6 /ml).

Percent normal sperms were higher ($P < 0.05$) in supplemented bulls than the control group in February (Figure 5). However, percent normal sperms for October and December were similar. There was no effect of month of collection and nutrition and percent normal sperm ($P > 0.05$).

Reproductive status of cows

Body condition scores and body weight

Body condition of cows improved significantly ($P < 0.05$) between August and October. However, body condition of the cows declined in December but increased thereafter (Figure 5). Changes in body weight of all cows

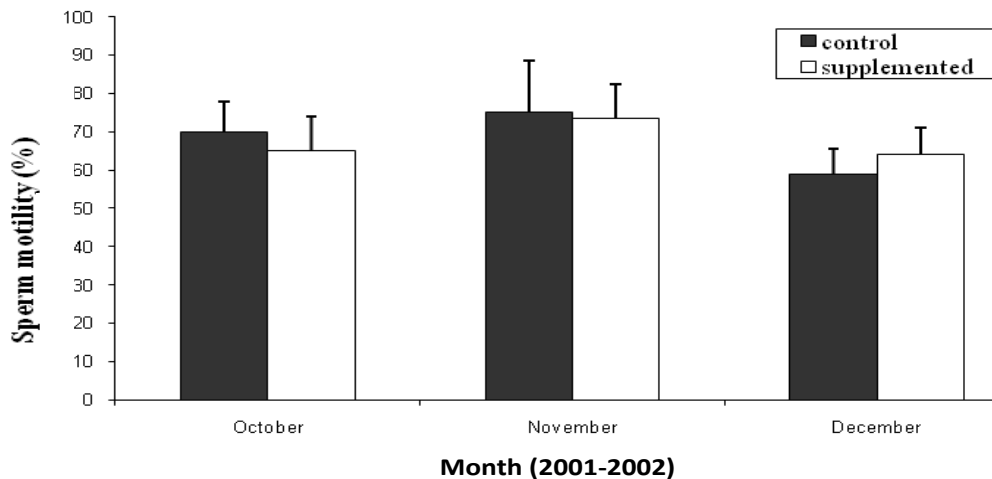


Figure 3. Changes in percent sperm motility in bulls in Sanyati smallholder area.

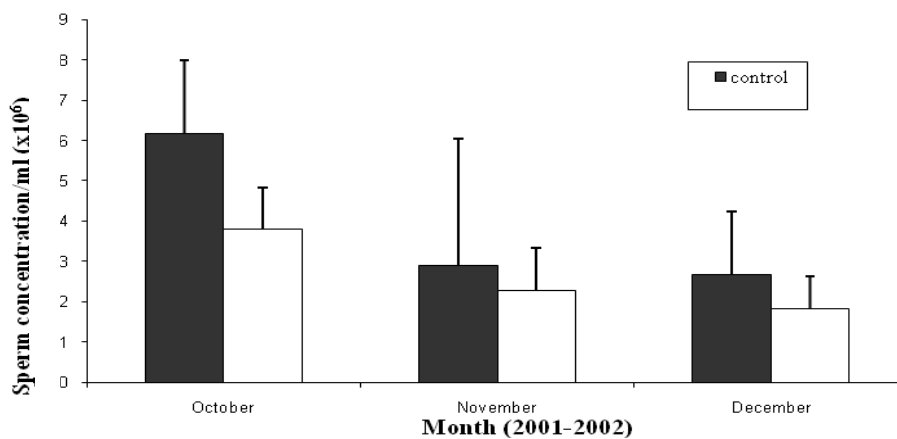


Figure 4. Changes in sperm concentration in bulls in Sanyati smallholder area.

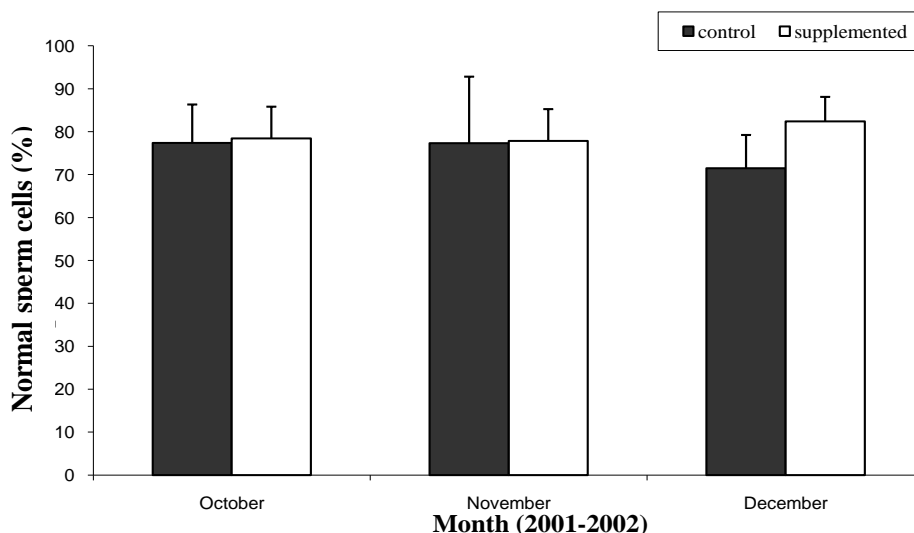


Figure 5. Changes in percent normal sperm in bulls in Sanyati smallholder area.

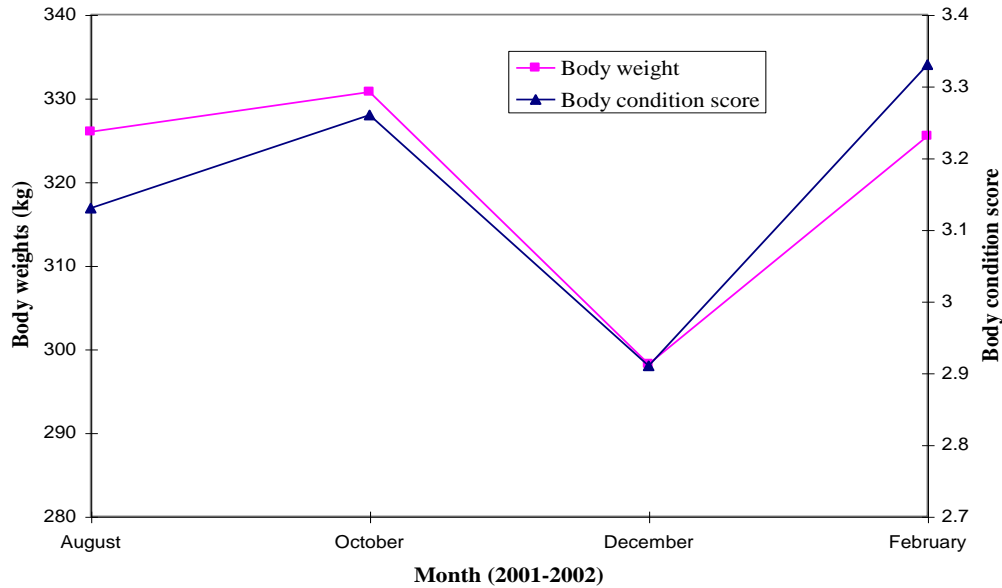


Figure 6. Changes in body condition and body weights of cows in Sanyati smallholder area from August 2000 to February 2002.

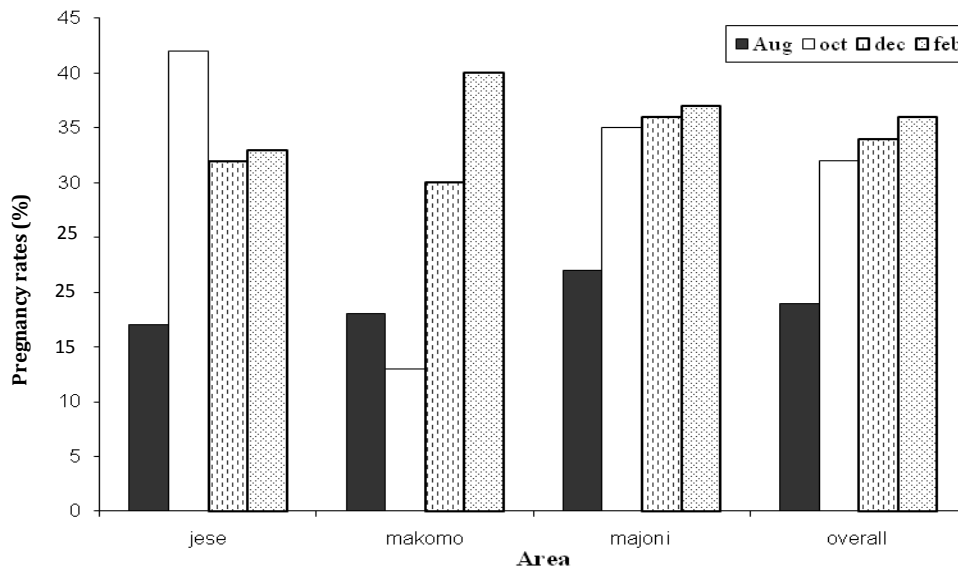


Figure 7. Cumulative pregnancy rates for cows in three villages of Sanyati smallholder area from August 2001 to February 2002.

followed a similar trend as the body condition scores. Lowest mean body weight (298 ± 15 kg) was recorded in December while the highest (330 ± 17 kg) was recorded in October, respectively.

Pregnant rates and ovarian function

Mean pregnancy rate for all cows was observed to

increase during the period of study in the three villages (Figure 6). The highest pregnancy rate (42%) was recorded for cows in Jese village in October while the lowest (13%) was recorded for cows in Makomo village during the same month. Figure 7 shows the prevalence of ovarian activity in cows in Sanyati. Exhibition of normal ovarian activity tended to decrease during the period of study. Highest ovarian activity (92%) was exhibited in cows in Makomo village in February.

DISCUSSION

In the study, the decline in body condition and body weights of the supplemented bulls between September and December was not expected. It appears therefore that the supplementary feed could not adequately meet the protein and energy requirements of the bulls during the dry season. However, the decline in the body condition and body weights of non-supplemented bulls was expected. This might have been a direct response to a corresponding deterioration in quality and quantity of the feed resources available in Sanyati as prevalent in many smallholder areas of Zimbabwe during the dry season and under grazing conditions as reported elsewhere (Tegegne et al., 1994; Chimonyo et al., 2000). With increasing abundance of high quality feed during the rainy season by December, all the bulls in the study started to gain body weight and body condition. This is in agreement with the findings of Francis (1993).

Absence of significant effect of nutrition on scrotal circumference is contrary to the findings by Wilders and Entiwstle (1984) who observed a close association between nutrition and testes size. High scrotal circumference has been observed to be positively correlated with high sperm production (Spitzer et al., 1997).

Due to the fact that bulls were actively breeding during the period of study, there was inconsistency of bulls in sperm output in response to electro ejaculation. Thus semen volumes were varied with month of collection. However, there was no influence of nutrition or month of collection or nutrition on semen volume. Percentage sperm motility values were comparable with the values reported for indigenous zebu bulls in Nharira-Lanchashire (Mbereg, 2000). Percentage sperm motility was above the minimum recommended by the Society of Theriogenology (Spitzer et al., 1998).

Quality semen is required to consist of high levels of live normal sperms to increase the chances of fertilization. Percent normal sperm in all bulls in the study was above the minimum threshold recommended by the Society of Theriogenology (Spitzer et al., 1998). Absence of nutritional influence on semen characteristics is in agreement with findings of Coulter and Kobuz (1984) and Henandez et al. (1991). However, this is contrary to the findings by Tegegne et al. (1994) which showed that high plane nutritional supplementation influenced semen volume and sperm concentration.

The decline in body weight of cows in December could be a result of the use of cows for draught purposes. This is confirmed by the fact that before the start of the rainy season (August-October), the cows were in good condition and had high average body weights. With reduction of draught work by February, there was an increase in body weight. In Sanyati and many smallholder areas of Zimbabwe, the shortage of draught oxen has forced many farmers to use cows for draught purposes

(Chimonyo et al., 2000).

Ovarian activity in cows in Sanyati was observed to decline during the period of study. Decreasing ovarian activity in cows during the October to December period coincided with the period they exhibited lowest body weights. This could probably be due to the use of cows for draught work and also insufficient intake of nutrients to meet their nutritional requirements. Reduced energy intake in combination with work stress has been shown to suppress ovarian activity in draught cows (Chimonyo et al., 2000). Generally, pregnancy rates improved during the period of study. With the onset of rainy season and resumption of growth of good quality grass and browse, the body condition of the cows improved. This could have increased the chances of conceiving.

Although the semen characteristics of the bulls in the area were of quality and above the minimum thresholds recommended by the Society of Theriogenology (Spitzer et al., 1998), the observed low conception rates in previous studies could be partly due to low sexual aggressiveness of the bulls, limited access of cows to bulls and social dominance among the bulls in the area. With the introduction of performance tested Tuli bulls, the bull to cow ratio increased. Cows on heat had more access to the bulls resulting in an increase in cumulative pregnancy rates of cows in the area.

Before this study was conducted, the farmers in the Sanyati had no knowledge on the importance of genetically superior male animals in improvement of fertility in their cattle herds. This has resulted in castration of male calves early in life as a strategy to increase the number of draught oxen. Small and genetically poor males thus remained entire and continued to breed resulting in the production of inferior animals. Furthermore, the farmers in the area had difficulties in identifying sub-fertile or sterile bulls because multi-sire herds were run. Consequently, low pregnant rates and long calving intervals were observed (Masunda, 2001). Examination of the bulls enabled identification of some of the causes of poor bull fertility in the herds. In addition, it enabled the farmers to fully recognize the importance of proper bull management to optimize performance.

Conclusion

Dry season supplementary feeding did not influence changes in body weights and scrotal circumference of bulls. In addition, no nutritional effects were observed on semen volume, sperm motility, sperm concentration and percent normal sperm. Observed increase in pregnant rates during the period of study might be due to the additional purchased Tuli bulls increasing the bull to cow ratio. Decline in ovarian activity in cows during the period of study was probably due to combined effects of work stress and low nutrient intake due to short grazing periods. The study enabled farmers to appreciate the

importance of evaluating bulls as well as in identifying some of the causes of poor fertility. Furthermore, it enabled the farmers to recognise the importance of proper bull management to optimise reproductive efficiency in cattle herds.

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