

New Zealand Society of Animal Production online archive

This paper is from the New Zealand Society for Animal Production online archive. NZSAP holds a regular annual conference in June or July each year for the presentation of technical and applied topics in animal production. NZSAP plays an important role as a forum fostering research in all areas of animal production including production systems, nutrition, meat science, animal welfare, wool science, animal breeding and genetics.

An invitation is extended to all those involved in the field of animal production to apply for membership of the New Zealand Society of Animal Production at our website www.nzsap.org.nz

[View All Proceedings](#)

[Next Conference](#)

[Join NZSAP](#)

The New Zealand Society of Animal Production in publishing the conference proceedings is engaged in disseminating information, not rendering professional advice or services. The views expressed herein do not necessarily represent the views of the New Zealand Society of Animal Production and the New Zealand Society of Animal Production expressly disclaims any form of liability with respect to anything done or omitted to be done in reliance upon the contents of these proceedings.

This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](http://creativecommons.org/licenses/by-nc-nd/4.0/).



You are free to:

Share— copy and redistribute the material in any medium or format

Under the following terms:

Attribution — You must give [appropriate credit](#), provide a link to the license, and [indicate if changes were made](#). You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

NonCommercial — You may not use the material for [commercial purposes](#).

NoDerivatives — If you [remix, transform, or build upon](#) the material, you may not distribute the modified material.

<http://creativecommons.org.nz/licences/licences-explained/>

Predicting the onset of nutritional anoestrus in Brahman heifers

F.M. RHODES

Dairying Research Corporation, Private Bag 3123, Hamilton, New Zealand.

ABSTRACT

The objectives of this study were to monitor the physiological events associated with decreasing liveweight in *Bos indicus* heifers and to determine the characteristics which best predicted the onset of nutritional anoestrus. Eleven post-pubertal Brahman heifers received a diet resulting in a liveweight loss of 0.7 kg/day. Changes in ovarian morphology were monitored using daily transrectal ultrasonography. Liveweight was recorded twice weekly. Heifers became anoestrus after 98 ± 9 days, following a decrease in liveweight of 68.6 ± 4.9 kg, equivalent to $21.5 \pm 1.5\%$ of initial weight. At this time, maximum diameters of ovulatory follicles and corpora lutea (CL) had decreased by $16.7 \pm 3.9\%$ and $23.7 \pm 3.1\%$, respectively. Onset of anoestrus was best predicted by liveweight and maximum diameter of CL when expressed as proportions of initial liveweight and size of CL. The percentage decreases in liveweight and maximum diameter of CL to give a 50% probability of anoestrus were 21.0% (95% confidence interval = (17.7, 27.4)) and 23.0% (16.7, 37.0), respectively

Keywords: *Bos indicus*; nutrition; anoestrus; ovary.

INTRODUCTION

The beef industry in northern Australia is mainly based on the utilisation of either native or improved pastures. Patterns of animal growth reflect forage availability, with rapid weight gains during the summer (wet season) followed by weight losses in late winter-spring (dry season). The degree of weight loss during the dry season is negatively correlated with subsequent pregnancy rates in both maiden heifers and mature cows (Doogan *et al.*, 1991; O'Rourke *et al.*, 1991). In maiden heifers, there is a curvilinear relationship between pregnancy rates and liveweight at mating, with pregnancy rates being very low for heifers weighing < 250 kg (Doogan *et al.*, 1991). Previous studies using *Bos taurus* cattle, have reported that animals become anoestrus following a decrease in liveweight of 20% (Imakawa *et al.*, 1986) or 24% (Richards *et al.*, 1989). However, neither authors indicated the degree of between-animal variation in sensitivity to nutritional stress, nor did they examine which physiological characteristics best predicted the onset of nutritional anoestrus. The aims of the current study were to monitor changes in a number of physiological characteristics during a period of decreasing liveweight in *Bos indicus* heifers and to determine which best predicted the onset of nutritional anoestrus.

MATERIALS AND METHODS

The study was performed at James Cook University, Townsville, (latitude 19°19'S; longitude 146°43'E) in the dry tropics of North Queensland. Eleven post-pubertal Brahman heifers weighing 319 ± 4.0 kg (mean \pm sem) received a restricted diet of sorghum hay, which resulted in a daily liveweight loss of 0.7 ± 0.04 kg until the onset of anoestrus. Heifers were subsequently fed an *ad libitum* diet until resumption of oestrous cycles. Liveweight was re-

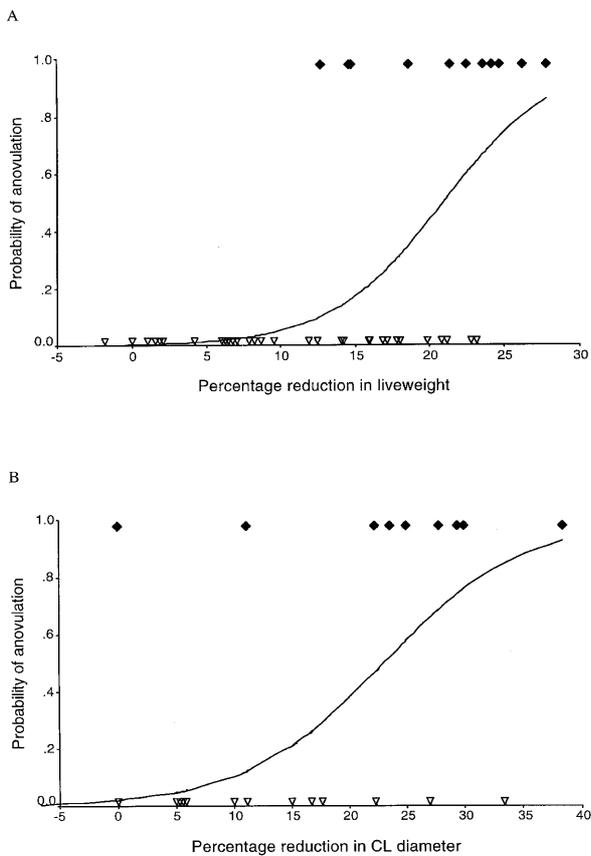
corded twice weekly. Changes in ovarian structures were determined using daily transrectal ultrasonography (Savio *et al.*, 1988). Ovulation was determined by the disappearance of a dominant follicle and subsequent formation of a corpus luteum in the same location on the ovary. Anoestrus was defined as failure of ovulation of a dominant follicle following luteolysis. Timing of onset of anoestrus in treatment heifers was modelled using logistic regression. The variables initially included in the model were liveweight, maximum diameter of corpora lutea (CL), first dominant follicles and ovulatory follicles; persistence of first dominant follicles and growth rate of ovulatory follicles. All explanatory variables were expressed as proportions of their values preceding initiation of liveweight loss. A subset of significant explanatory variables was determined using backward elimination of non-significant variables ($P > 0.05$), based on the likelihood-ratio test (Collett 1991). Multiple regression analysis was used to examine the relationship between a number of variables and the duration of the period of liveweight loss before onset of anoestrus.

RESULTS

Decreasing liveweight was associated with a proportional decrease in sizes of ovarian structures. A 10% decrease in liveweight resulted in an estimated $8.5 \pm 0.8\%$ decrease in ovulatory follicle size and a $10.6 \pm 0.9\%$ decrease in the maximum diameter of CL. Heifers became anoestrus after 98 ± 9 days (range 44 – 137), following a decrease in liveweight of 68.6 ± 4.9 kg (range 43 – 86), equivalent to $21.5 \pm 1.5\%$ (range 14 – 28) of initial weight. At this time, maximum diameters of ovulatory follicles and CL had decreased by $16.7 \pm 3.9\%$ and $23.7 \pm 3.1\%$, respectively. Onset of anoestrus was best predicted by liveweight ($\chi^2_{(1)} = 4.37$, $P = 0.04$) and maximum diameter of CL ($\chi^2_{(1)} =$

4.19, $P = 0.04$), when expressed as proportions of initial liveweight and size of CL. The percentage decreases in liveweight and maximum diameter of CL to give a 50% probability of anoestrus were 21.0% (95% confidence interval = (17.7, 27.4)) and 23.0% (16.7, 37.0), respectively (Fig. 1). The variation in the number of days to onset of anoestrus was inversely related to the rate of liveweight loss (adj $R^2 = 0.44$, $P = 0.02$), and also to the duration of the period of weight gain to resumption of oestrous cycles (adj $R^2 = 0.30$, $P = 0.05$, Fig. 2).

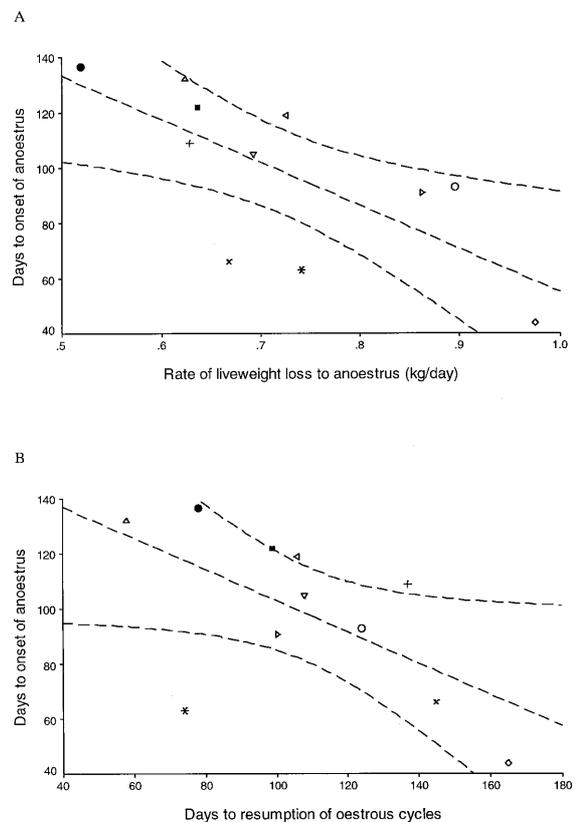
FIGURE 1: Relationships between decrease in liveweight (A) and diameter of corpora lutea (B) and probability of anoestrus (anovulation). Symbols indicate animals still cycling (∇) or anoestrus (\blacklozenge).



DISCUSSION

In agreement with previous studies using *Bos taurus* cattle (Imakawa *et al.*, 1986; Richards *et al.*, 1989), onset of anoestrus in Brahman heifers in the present study occurred following an average decrease of 21% in liveweight. However, there was considerable variation between animals in the time required to induce anoestrus, which was related to the duration of the period of weight gain before animals resumed oestrous cycles. This variation may reflect differences in sensitivity to nutritional stress. In the field, this would result in more sensitive animals ceasing reproductive activity relatively quickly after a decrease in forage availability. These animals would also require a longer period of liveweight gain before resuming oestrous

FIGURE 2: Fitted linear regression, with 95% confidence intervals for the mean predicted response of (A) interval to onset of anoestrus with rate of liveweight loss and (B) interval to onset of anoestrus with interval to resumption of oestrous cycles. Individual heifers are represented by different points.



cycles, possibly resulting in out-of-season calvings with associated increased survival risks.

The time taken for heifers to become anoestrus was also related to the rate of liveweight loss, suggesting that those animals which were able to limit the degree of weight loss, or which were more efficient in their metabolism of the limited food available, were able to delay the onset of anoestrus. However, the proportion of weight lost by heifers at the onset of anoestrus varied between 14% and 28%, indicating that there is not a threshold liveweight or minimum body fat content required for continued reproductive function in cattle, as has been suggested for human females (Frisch 1994).

The findings in the current study of a predictive relationship between liveweight loss and onset of anoestrus are consistent with reports of significant correlations between liveweight preceding mating and subsequent pregnancy rates in cattle herds (Doogan *et al.*, 1991; O'Rourke *et al.*, 1991). The present data confirm that increasing weight loss during a severe dry season will result in greater proportions of animals becoming anoestrus, thereby reducing the number of females able to conceive at the start of the mating period.

Onset of anoestrus was also predicted by percentage decrease in maximum diameter of CL. A 50% probability of anoestrus was expected following a decrease in size of CL of approximately 20%. It is unlikely that the reduction

in size of CL resulted directly in failure of ovulation, but that this decrease in size was a consequence of reduced development of ovulatory follicles during preceding oestrous cycles. Several studies have demonstrated a reduction in ovarian follicular size in cattle following restricted dietary intake (Murphy *et al.*, 1991; Bergfeld *et al.*, 1994; Burke *et al.*, 1996). Failure of ovulation is associated with reduced peripheral concentrations of luteinising hormone and is thought to result from failure of maturation of the ovulatory follicle (Rhodes *et al.*, 1995). However, the mechanisms linking reduced liveweight and hypothalamo-pituitary function await clarification.

In conclusion, restricted dietary intake in *Bos indicus* heifers resulted in animals becoming anoestrus after an average decrease in liveweight of 21%, which was associated with a decrease of 17% and 24% in the size of ovarian follicles and CL, respectively. However, there was considerable variation between animals in the duration of the period of weight loss and in the degree of weight loss required to induce anoestrus. This variation may reflect differences in sensitivity to nutritional stress and priorities for energy allocation.

ACKNOWLEDGMENTS

The assistance of Glenn De'ath with statistical analyses is gratefully acknowledged. This study was partially funded by the Australian Meat Research Corporation.

REFERENCES

- Bergfeld, E. G. M., Kojima, F. N., Cupp, A. S., Wehrman, M. E., Peters, K. E., Garcia-Winder, M. and Kinder, J. E. (1994). Ovarian follicular development in prepubertal heifers is influenced by level of dietary energy intake. *Biology of Reproduction* **51**: 1051-1057.
- Burke, C. R., Macmillan, K. L. and Verkerk, G. A. (1996). Hormonal induction of oestrus during the early postpartum period and the subsequent effects of nutrition on ovarian activity in dairy heifers. *Proceedings of the New Zealand Society of Animal Production*: **56**: 229-231.
- Collett, D. (1991). *Modelling Binary Data*, Chapman and Hall, London.
- Doogan, V. J., Fordyce, G., Shepherd, R. K., James, T. A. and Holroyd, R. G. (1991). The relationships between liveweight, growth from weaning to mating and conception rate of *Bos indicus* cross heifers in the dry tropics of North Queensland. *Australian Journal of Experimental Agriculture* **31**: 139-144.
- Frisch, R. E. (1994). The right weight: body fat, menarche and fertility. *Proceedings of the Nutrition Society* **53**: 113-129.
- Imakawa, K., Day, M. L., Garcia-Winder, M., Zalesky, D. D., Kittok, R. J., Schanbacher, B. D. and Kinder, J. E. (1986). Endocrine changes during restoration of estrous cycles following induction of anestrus by restriction of nutrient intake. *Journal of Animal Science* **63**: 565-571.
- Murphy, M. G., Enright, W. J., Crowe, M. A., McConnell, K., Spicer, L. J., Boland, M. P. and Roche, J. F. (1991). Effect of dietary intake on pattern of growth of dominant follicles during the oestrous cycle in beef heifers. *Journal of Reproduction and Fertility* **92**: 333-338.
- O'Rourke, P. K., Doogan, V. J., Robertson, D. J. and Cooke, D. (1991). Prediction of conception rate in extensive beef herds in north-western Australia. 2. Continuous mating and minimal management. *Australian Journal of Experimental Agriculture* **31**: 9-14.
- Rhodes, F. M., Entwistle, K. W. and Kinder, J. E. (1995). Endocrine and ovarian changes before the onset of nutritional anoestrus in *Bos indicus* heifers. *Journal of Reproduction and Fertility, Abstract Series* **15**: Abstract 60.
- Richards, M. W., Wettemann, R. P. and Schoenemann, H. M. (1989). Nutritional anestrus in beef cows: body weight change, body condition, luteinizing hormone in serum and ovarian activity. *Journal of Animal Science* **67**: 1520-1526.
- Savio, J. D., Keenan, L., Boland, M. P. and Roche, J. F. (1988). Pattern of growth of dominant follicles during the oestrous cycle of heifers. *Journal of Reproduction and Fertility* **83**: 663-671.