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Effect of level of nutrition on age of puberty and reproductive performance of Friesian heifers

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ABSTRACT

Six nutritional regimes were applied to 134 Friesian heifers to determine the effects of differential rearing on productive and reproductive performance.

Cycling animals were identified at 11.5 and 15 months by measuring progesterone in consecutive weekly blood plasma samples. Heifers were synchronised using CIDR devices and artificially inseminated for two cycles, followed by six weeks of natural mating.

At 11.5 months, 95% of the high (268 kg LW), 65% of the medium (242 kg LW), and 2% of the low (186 kg LW) nutrition groups were cycling. At 15 months, all heifers in the four high groups were cycling compared to only 82% of heifers in the two low groups. Nutrition, liveweight, and time of puberty did not affect conception date or empty rate. Reproductive performance of the low groups was probably enhanced by the CIDR progesterone treatment stimulating puberty in non-cycling heifers. Friesian heifers should average 300 kg to ensure all animals are cycling normally prior to the start of mating.

Keywords: Friesian heifers; puberty; mating; liveweight; nutrition; conception rate.

INTRODUCTION

Reproductive performance of replacement dairy heifers is a key variable contributing to a wastage rate of 28% (Bryant and McRobbie 1991). Heifers need to achieve optimum fertility by mating at 13 to 15 months of age. Management of replacement heifers so they reach puberty early may be of particular relevance. Increased fertility was demonstrated when heifers were bred to the third oestrus after puberty, compared to the pubertal oestrus (Byerley *et al.*, 1987). Heifers reach puberty when they experience their first oestrus followed by formation of a corpus luteum which is then maintained through a normal luteal phase (Kinder *et al.*, 1994). Genotype and environment both influence the age of puberty; however level of nutrition has the greatest influence on the age of puberty in the context of a seasonal calving system (Kinder *et al.*, 1994). Little information is available regarding genotypic nutritional interactions.

The effects of level of nutrition during rearing on subsequent milk production and reproductive performance of high genetic merit Friesian replacements is currently being examined at the Dairying Research Corporation (DRC). Effects of nutrition on age of puberty, the subsequent number of oestrous cycles before the planned start of mating, and conception rates were assessed in this study.

MATERIALS AND METHODS

Calves (n=134) were collected at four days of age from six dairy herds over a period from 1 August to 31 August 1992, and reared to 22 months at the DRC Ruakura No 4 Grazing Unit. They were then returned and milked as part of their herd of origin.

All calves were commonly reared to achieve a target liveweight (LW) of 90 kg at 10 weeks of age. Three groups balanced for liveweight, pre-weaning liveweight gain, herd, sire, ancestry breeding index (BI), and age were formed at weaning and allocated to nutritional regimes aimed at achieving liveweight gains of 0.8, 0.6 or 0.4 kg LW/day (H, M, or L). When each group averaged 200 kg LW, the calves were allocated to nutritional regimes to achieve liveweight gains of either 0.7 or 0.5 kg LW/day (H or L). The heifers on the high (H), medium (M), and low (L) level of nutrition attained mean liveweights of 200 kg on 10 March, 14 April and 22 July 1993, respectively, and were then split into the high and low (HH, HL, MH, ML, LH, and LL) nutritional sub-groups. Each animal was weighed every 14 days. Liveweight gain was manipulated by adjusting pasture allowance, and the amount of supplementary feed offered.

Concentrations of progesterone in plasma were determined by radioimmunoassay in samples obtained over three consecutive weeks at 11.5 and 15 months of age. It was assumed that an animal was cycling when progesterone concentrations exceeded 3 ng/ml in at least two of the three samples (Little *et al.*, 1981).

Heifers were synchronised with intravaginal CIDR devices according to the Genermate™ programme, as described by Cliff *et al.*, (1995). They were artificially inseminated when heat was detected with the aid of tail paint and raddle at 48, 72, and 96 h after CIDR device removal. Previously used devices were reinserted in all heifers for 5 days from 18 days after their original removal to re-synchronise returns to service to be re-inseminated 48 and 72 h after removal for the second time. Chin-harnessed bulls grazed with the groups from 3 days after first insemination until re-insertion of the CIDR devices, and from 24 h following the last second insemination until late December. Conception dates were based on the diagnosis of pregnancy by rectal palpation 6 weeks after the first, second, and final successive mating cycles.

Data were analysed by logistic regression for the proportion of animals in each category by treatment, and the appropriate liveweight.

RESULTS

The nutritional treatments resulted in large differences in mean liveweights, and the proportions of each group that were cycling at 11.5 months of age ($p<0.001$) (Table 1). Whereas 95% of the heifers in the HH and HL groups had started cycling, 86% and 48% of the heifers in the MH and ML groups, and only 2% of the heifers in the LL and LH groups were cycling.

There were eight heifers which had not cycled by 15 months, including five from the LL group (23%), and three from the LH group (13%). The liveweight of the non-cyclers ranged from 130 to 258 kg at 11.5 months and 233 to 286 kg at 15 months.

TABLE 1: Mean weaning liveweight (23 October 1992), liveweight and number of heifers cycling at 11.5 and 15 months of age, and the number of heifers in-calf to the first, second, and third cycle of mating, and that were empty.

Group	LL	LH	ML	MH	HL	HH	sed*
n	22	23	23	22	22	22	
Liveweight 2.5 months (kg)	91	91	91	92	90	92	2.8
Liveweight 11.5 months (kg)	186	186	231	253	256	279	6.5
Number cycling 11.5 months	0	1	11	19	21	21	2.9
Liveweight 15 months (kg)	256	276	292	320	308	359	7.3
Number cycling 15 months	17	20	23	22	22	22	1.6
Number of animals in-calf							
First mating cycle	14	19	16	14	16	13	3.2
Second mating cycle	4	1	5	5	4	4	2.7
Third mating cycle	2	1	2	2	1	1	1.7
Number of empty heifers	2	2	0	1	1	4	2.3

*Sed from Anova for continuous data, conservative sed for count data based on binomial distribution.

There were no significant differences in the reproductive performance of the treatment groups as measured by in-calf rate to the first, second, and third matings, or the number of empty heifers (Table 1). This was so, even though the proportion of heifers cycling in the individual groups ranged from 0-100% at 11.5 months, and 77-100% at 15 months. Across all groups, animals that were, or were not cycling at 11.5 months had conception rates to first mating of 65% and 72%, and empty rates of 8.2% and 6.2%, respectively.

DISCUSSION

Despite large differences in liveweight, and the number of animals cycling at 11.5 months in each group, there were no differences in pregnancy rates, conception pattern, or the proportion of empty heifers. Reproductive performance was not enhanced by achievement of puberty well before the planned start of mating, contrary to the findings of Byerley *et al.*, (1987). Provided all heifers are cycling, and are submitted for mating, a high level of reproductive performance can be achieved in Friesian heifers with mean mating liveweights as low as 256 kg. Level of nutrition and liveweight had a large effect on the age at puberty, but did not effect subsequent reproductive performance, in agreement with Little *et al.*, (1981).

In the present trial, progesterone treatment of all animals using a CIDR device stimulated puberty in the non-cycling heifers (17%) in the LL and LH sub-groups. Had these non-cycling heifers not been subjected to the CIDR treatment, they may have reduced the submission rates during the first 3 weeks of natural mating, delaying the mean conception date of those groups. Late calving heifers are more susceptible to poor reproductive performance than older herd mates because of a long post partum anoestrous interval (Burke *et al.*, 1994). This is a major contributing factor to a high wastage rate among rising 3 year old cows (Bryant and McRobbie 1990). In a study involving 2973 British Friesian heifers, Drew (1986) demonstrated a 33.8% calving rate to first insemination when heifers weighing less than 260 kg were synchronised using two injections of prostaglandin, compared to a calving rate of 58.0% if they weighed more than 300 kg. Lower calving rates of the lighter heifers may have been caused by a proportion of the heifers being pre-pubertal. The prostaglandin synchrony used by Drew (1986) will not induce cycling in pre-pubertal heifers in contrast to the situation when progesterone treatments are used for synchrony. Macmillan *et al.*, (1990) showed that only 9.8% of 695 naturally mated heifers in 15 South Taranaki herds calved in the first week of calving compared to 25.6% in the third week. It was suggested this calving pattern occurred because some of the heifers were anoestrus at the commencement of mating.

The majority of heifers in New Zealand are naturally mated and therefore rely on Nature to ensure they are all cycling. These data suggest that a mean liveweight of 280 kg at mating (Penno, 1994) may be too low to ensure that every Friesian heifer reaches puberty and is cycling at the start of mating. Friesian heifers should attain a mean liveweight of 300 kg prior to the start of mating. Poor calving patterns will occur if a proportion of the heifers are too light, resulting in decreased days in milk and may reduce subsequent mating performance. If replacement heifers fail to attain an adequate mating weight, treating non-cycling animals with progesterone immediately prior to mating to stimulate puberty may be an appropriate way of achieving an improved reproductive performance.

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