The effect of feeding level during rearing on the first lactation milk yield of Friesian replacement heifers

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ABSTRACT

Six nutritional regimes were imposed on Friesian heifers (n=270) from weaning to 22 months of age to determine the effect of level of feeding during rearing on subsequent milk production. Nutritional treatments resulted in groups weighing 480, 406, 455, 376, 398, and 342 kg ($P<0.05$) at 22 months of age. However, once the heifers entered the herd differences liveweight were lost. By 28 months of age the difference between the heaviest and lightest treatment groups was only 44 kg ($P<0.05$). Level of feeding from 90 to 200 kg liveweight had no effect on subsequent milkfat or protein yield ($P>0.05$). Heifers offered a high feeding level after 200 kg produced 9.6 kg more milkfat ($P<0.01$) and 6.6 kg more protein ($P<0.01$) than heifers offered the low feeding regime. These data suggest that Friesian heifers produce an additional 0.12 kg MS over their first lactation for each additional 1 kg liveweight gained during rearing.

Keywords: dairy; heifer replacements; rearing; liveweight; milk yield.

INTRODUCTION

Dairy replacements are sourced by retaining a proportion of the high genetic merit heifer calves born each spring. The milk yield a replacement heifer achieves in her first lactation is a function of genetic merit and feeding level. Much is known about the effect of feeding level after calving on milk production. Penno (1995) defined the amounts of feed necessary to grow heifers to certain liveweights. However, less is understood about the effect of feeding level during rearing on subsequent milk production.

New Zealand liveweight (LW) targets for replacement heifers vary widely, and are not based on experimental evidence. The only New Zealand experiment designed to examine the effects of heifer liveweight on subsequent milk production was conducted by McMeekan from 1947 - 1958. McMeekan (1958) demonstrated that the benefits of rearing larger Jersey replacements were small (0.15 kg milkfat/kg LW). Based on McMeekans data, low liveweight targets were recommended (Scott et. al.,1980), and remained in place until recently.

The Dairying Research Corporation (DRC) established a research programme in 1992 to determine the effect of level of feeding during rearing on the lifetime performance of Friesian and Jersey heifer replacements. This paper reports the first lactation milk yield data for the Friesian replacements.

METHODS

Friesian heifer calves (n=270) by LIC Premier Sires were collected at 4 days of age from 5 commercial farms during 1992 and 1993. Each spring the calves were collectively reared to a mean liveweight (LW) of 90 kg LW at 10 weeks of age. At 90 kg LW, the calves were split into three groups and fed to achieve either a high (H), medium (M), or low (L) level of liveweight gain (0.8, 0.6, or 0.4 kg/day, respectively) until the group attained an average liveweight of 200 kg LW (Period 1). At 200 kg LW each group was again split and fed to achieve either a high (HH, MH, and LH) or low (HL, ML, and LL) level of liveweight gain (0.7 or 0.5 kg/day) from 200 kg LW to 22 months of age (Period 2). Liveweight was controlled by manipulating pasture and supplementary feed allowance according to liveweight gain over the preceding fortnight. At 22 months of age the calves were returned to their owners and milked as part of the commercial herd. Liveweight was measured regularly thoughout the trial and subsequent milk yield and composition was measured by monthly herd test. Two years of data were combined and analysed by analysis of variance adjusted for farm, year, sire, calving date, and age.

RESULTS

Table 1 contains the mean liveweight of each treatment group achieved at 15 months of age, and the mean liveweight and condition score at 22 and 28 months of age. The feeding treatments resulted in significant ($P<0.05$) differences in liveweight when the heifers were returned to their respective owners at 22 months of age. The HH treatment resulted in an average liveweight of 480 kg by 22 months of age and the LL treatment only 342 kg LW. However, 4 months after the calving these differences had been eroded. The HH treatment group lost 69 kg LW between 22 and 28 months of age, while heifers in the LL treatment continued to gain LW. At 22 months the HH group weighed 138 kg more than the LL group, whereas at 28 months of age the difference was only 44 kg ($P<0.05$). Changes in condition score followed a similar pattern.

The difference in first lactation milksolids (MS) yield were small (Table 1). The largest difference between treatment groups was 28 kg milksolids/cow with the MH groups producing 11.2% more ($P<0.05$) than the HL group.

TABLE 1: Target liveweight (LW) gain of each treatment group during period 1 (90 kg LW - 200 kg LW) and period 2 (200 kg LW to 22 months of age), and the resulting mean LW at 15 months of age, mean LW and cow condition score at 22 and 28 months of age, and first lactation milkfat, milk protein, and milksolids yield.

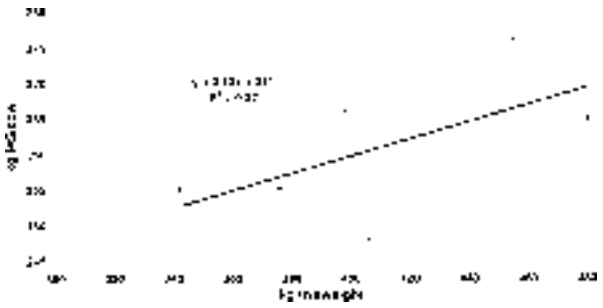
Treatment	HH	HL	MH	ML	LH	LL	sed
Period 1 target LW gain (kg/cow/day)	0.8	0.8	0.6	0.6	0.4	0.4	
Period 2 target LW gain (kg/cow/day)	0.7	0.5	0.7	0.5	0.7	0.5	
Liveweight at 15 months (kg/cow)	340^{a}	301^{b}	314^{b}	279^{c}	270^{c}	252^{d}	6.8
Liveweight at 22 months (kg/cow)	480^{a}	406^{c}	455^{b}	376^{d}	398^{c}	342^{e}	9.4
Cow condition at 22 months	5.6^{a}	4.7^{c}	5.2^{b}	4.3^{d}	5.1^{b}	4.1^{d}	0.11
Liveweight at 28 months (kg/cow)	411^{a}	393^{ab}	408^{a}	377^{b}	379^{b}	367^{b}	8.7
Cow condition at 28 months	4.5^{ab}	4.4^{b}	4.7^{a}	4.7^{a}	4.6^{ab}	4.6^{ab}	0.12
First lactation milkfat yield (kg/cow)	150^{ab}	140^{b}	157^{a}	144^{ab}	151^{a}	145^{ab}	5.5
First lactation protein yield (kg/cow)	115^{ab}	108^{b}	119^{a}	111^{b}	114^{ab}	110^{b}	4.0
Milksolids yield (kg/cow)	265^{abc}	248^{c}	276^{a}	255^{bc}	266^{ab}	255^{bc}	9.1

means of differing superscript letters are significantly different ($P<0.05$)

TABLE 2: The effect of extra liveweight at calving on annual yield of milkfat (MF) and protein (MP) attained from grazing based experiments in New Zealand and Australia.

Study	kg MF/kg LW	kg MP/kg LW
McMeekan (1958)	0.15	-
Valentine *et al.*, (1987)	0.23	0.12
Stewart and Taylor (1990)	0.16	0.14
This Study	0.07	0.05
Average	0.15	0.10

FIGURE 1: Relationship between average group liveweight at 22 months of age and first lactation milksolids yield (kg MS/cow).



The HH group produced no more than the MH group despite being 25 kg heavier ($P<0.05$) at 22 months of age. Further, the LH group produced an extra 18 kg MS ($P<0.05$) during their first lactation compared to the HL, yet had similar mean LW at 22 months. Feeding level during period 1 had no effect on first lactation yields of milk fat or milk protein ($P<0.01$). However, heifers reared at the high feeding level from 200 kg LW to 22 months produced 9.6 kg more milkfat ($P<0.01$), and 6.6 kg more milk protein ($P<0.01$) during their first lactation than those reared under the low feeding level after 200 kg LW. Overall, each additional 1 kg LW at 22 months of age, produced an extra 0.12 kg MS during the first lactation (Figure 1), comprising 0.07 kg milkfat and 0.05 kg milk protein (Table 2).

DISCUSSION

Much of the current data relating calving liveweight to subsequent milk production are based on surveying large populations, or comparing individuals within commercial or research herds. Often no attempt was made to differentiate between differences in liveweight due to genetic or environmental factors other than level of nutrition. Therefore, estimates of the value of additional liveweight at first calving are variable. Based on a survey of 16 Victorian dairy farms, Thomas and Mickan (1987) concluded that liveweight had almost no effect on first lactation milk yield. Conversely, Cowen et al., (1974) estimated from a survey of 78 heifers in Queensland that each additional 1 kg LW at first calving would result in at total of 23 l additional milk over the first three lactations. Such survey data should only be taken as indicative that additional liveweight at calving has a positive effect on first lactation milk yield (Bryant and McRobbie, 1991).

Few experiments have been conducted which allow the relationship between calving liveweight and subsequent milksolids production to be quantified for pastoral dairying. The overall milksolids response to additional liveweight at the end of rearing (22 months) are small in comparison to other studies (Table 2). It would appear that any differences in milk production are simply a result of the additional cow condition of the treatment groups, rather than differences in body size. The converging of liveweight and body condition of the groups within four months of calving suggests body fat was mobilised in early lactation to support milk production, allowing lower feed intake. The increase in milksolids production caused by the high feeding levels during Period 2 also support body fat being of greater importance than body size. Indeed, additional liveweight gained between 15 and 22 months of age resulted in 0.38 kg MS/kg LW ($R^2=0.7$). This is closer to the estimate of Bryant and McRobbie (1991) who suggested from the work of McMeekan (1954), and New Zealand survey data, that additional liveweight will increase first lactation milk yields by 0.36 kg MS/kg.

Although current data are insufficient to formulate new target liveweights they support current recommenda-

tions. Target liveweights, and the effect of liveweight on milk production, must be relative to the mature liveweight of the cow. North American targets for Holstein Friesians are 600 - 650 kg before calving (Heinrichs, 1993). In recent years Australia has seen increased use of North American genetics, and consequently recommended liveweight targets have been increased to 525 - 550 kg for Friesians (Moran, 1995). Clearly, these targets are inappropriate in New Zealand where the mature liveweight of a New Zealand type Friesian is approximately 450 - 500 kg.

Troccon (1993) estimated that the liveweight of 6 month heifers should be 30% of mature liveweight. Likewise, heifers at mating (15 months) and calving (24 months) should weigh 60% and 90% of their mature body weight. Targets liveweights using these criteria for a range of mature liveweights are presented in Table 3. Given that the mature liveweight of the animals involved in this experiment was approximately 500 kg, the assumptions of Troccon (1993) appear sound. The target mating weight of 300 kg at 15 months agrees with that derived from this experiment (Penno, 1995).

TABLE 3: Preliminary liveweight targets for replacement heifers based on mature liveweight as suggested by Troccon (1993).

Mature liveweight (kg)	**350**	**400**	**450**	**500**	**550**	**600**
6 Months	105	120	135	150	165	180
Mating	210	240	270	300	330	360
Calving	315	360	405	450	495	540

CONCLUSIONS

Increasing the feeding level of replacement heifers during rearing will result in modest increases in milksolids production during the first lactation. The potential benefits are likely to exist to a maximum of 90% of the indervidual's mature live weight. Emphasis should be placed on attaining high condition score targets at the end of the rearing period.

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