The effect of cow age and management of winter liveweight gain, liveweight at calving and subsequent effects on dairy production in a seasonal supply herd

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ABSTRACT

Dairy farmers often debate the importance of liveweight of rising 2 year old heifers and the value of various heifer wintering systems on subsequent production. Lifetime performance of all dairy cows born on the Taranaki Agricultural Research Station have been recorded since 1978 on a computerised data base. This data base was utilised to determine the liveweight gain of heifers and cows over winter and the effects of this on production in the following season.

Initial analysis of the data showed a significant ($P<0.01$) age effect on winter liveweight gain within a mixed age herd of cows. The average liveweight gain over eight years of the older cows (4 yr+) was 3 times that of the rising 2 year olds. Further analysis showed a significant ($P<0.05$) age effect on the relationship between liveweight at calving and production of milkfat in the following season. Higher liveweight at calving resulted in a greater increase in production for 2 year olds than for older cattle. The conclusion to be drawn from this is that wintering rising 2 year old heifers separately from older cows to achieve higher liveweights may have beneficial effects on the following seasons production.

A field trial in winter 1990 to test this assumption showed the winter liveweight gain of rising 2 year old heifers and mature cows, offered the same herbage allowance, was significantly ($P<0.01$) higher when wintered separately than wintered as a mixed age herd. Subsequent milk solids production from the two-wintering systems was the same despite different liveweight at calving. Aspects of herd behaviour were suggested as the cause of the nil response.

Keywords Age, liveweight, condition, milk solids, production, wintering systems, herd, behaviour.

INTRODUCTION

Cow liveweight or condition at calving is reported as a significant factor affecting dairy production (Hutton and Parker, 1973; Rogers *et al.*, 1979; Grainger *et al.*, 1982). Macmillan and Bryant (1980) from an analysis of information from 31 herds in the Waikato reported that cow condition at calving had a more marked effect for the two and three year old cows than for the mature cows. This information has lead to the conclusion that for high milk solids production it is important to have young cows in good condition or at high liveweight at calving. In general, farmers believe that having young cattle in good condition by first calving is an investment for future production. To achieve this or maintain previously gained condition, wintering systems involving herds of different age groups are devised. Although split-herd wintering (two and three herds of different age or condition) is commonly practised there is no definitive information substantiating the reported effects of different wintering systems on liveweight or condition at calving and on subsequent milk solids production.

EXPERIMENTAL

To evaluate the effects of winter management on the liveweight/condition/milk solids production relationships in dairy cattle a programme was initiated at the Taranaki Agricultural Research Station (TARS) in 1989. The programme initially involved an analysis of a data base of performance for all dairy cattle on TARS over a nine year period to determine the effects of age on changes over winter in liveweight and condition and the importance of these factors at calving on milk solids production. Information obtained from the analysis of the data base led to the development of a field trial to evaluate the performance of rising two year dairy cattle wintered under different management systems.

The Herd

The TARS herd of 220 cows was built up from 1976 to 1980 through the purchase of high BI stock, (breed, was not considered a factor). Until 1985 all cows were mated to Jersey using the N.Z Livestock Corporation "bull of the day" semen. After 1985 half the herd was mated Jersey and half Friesian. The herd in 1989 was approximately 50% Jersey and 50% Jersey x Friesian.

After weaning heifer calves were reared off the milking area and brought into the herd in early June as rising two year olds. They were then wintered as one mob with the rest of the herd under a 90-120 day rotational strip grazing system. The average date for start of calving over the period of analysis was 5 August.

Data Base

From the 1980/81 season onwards information on the performance of all cows on TARS was recorded in a computerised data base. The information entered included liveweight at birth, weaning and at mating; liveweight and condition score at entry into the herd in June (21 months old), at first calving and for each June and calving for each year of the cows life. The yield of milk, fat, protein and lactose for each lactation over the cows lifetime was also entered. Other data recorded, was year, breed, B.I (for cows four years and older only), treatment and stocking rate. Each year all cows were involved in research programmes and subjected to different treatments. However the greater proportion of cows were involved in farmlet studies and remained on their respective treatments for the duration of the trial which was usually four years. Cows were wintered on their respective farmlets but the management, ie. age structure of mobs, rotation length, feeding levels and calving date was similar.

Analyses

1. Age effects on winter liveweight gain. Eight years data; 1980/81 - 1988/89 was analysed to determine age effects (rising 2 year heifers (n = 48-56/year), rising 3 year heifers (n = 33-38/ year) and mature cows (four year old and older, n = 130-140/year) on liveweight gain from early June (when rising 2 year heifers entered the herd to calving (mean calving date, 21 August).

2. Age effects on the relationships between liveweight and condition at calving and milk solids production. Nine years data was included in this analysis; 1980/81 to 1989/90 dairy seasons and involved the comparison of the above relationships for rising 2 year heifers (n=450) and mature cows (4 years and older, n = 1210).

Analytical methods used for examining the two effects were similar through the construction of a general model then adjusted for year, stocking rate, breed, age and their first order interactions to determine the specific effect of age on winter liveweight gain. The linear effect of liveweight at calving and the interactive effect of liveweight and age on milk solids production were again tested in a general linear model after adjusting for year, stocking rate, breed, age and their first order interactions.

Field Trial

In winter 1990 a trial was run to determine the effects of heifers and cows in separate age groups or as one mixed age mob on liveweight at calving and subsequent milk solids production. Ninety cows (3 year and older) and 20 rising 2 year heifers were randomly allocated to one of three treatments: mixed age (45 cows plus 10 heifers), separate cows (45 cows), separate heifers (10 heifers) according to age, breed, calving date, liveweight, condition, B.I for cows and P.I for heifers. Animals were on their respective treatments from June 28 until 75% had calved. As cows and heifers calved they were run as a single mixed age milking herd. The grazing treatments were applied so that the individual herds were managed to provide a herbage allowance of 9 kg DM/cow or heifer/day of pasture at similar herbage mass and stock density (cow/m^2/day).

To achieve a similar herbage allowance, herbage mass and composition, the three treatment groups were simultaneously block grazed using temporary electric fences within the same paddocks over the duration of the grazing treatments. Herbage was constantly monitored using the electronic pasture probe to ensure constant herbage allowances were maintained. At

TABLE 1 Significant factors affecting liveweight gain in a mixed age herd from June.

Year	81	82	83	84	85	86	87	88
SR	NS	**	***	NS	NS	NS	***	***
Breed	NS	NS	NS	NS	NS	NS	NS	NS
L.W.T. June	NS	NS	NS	NS	**	NS	NS	*
Age	***	***	***	***	*	***	***	NS
Calving Date	**	*	***	***	***	***	***	***
S.R x Age x Breed	**	*	NS	NS	*	NS	NS	NS

* P<0.05; ** P<0.01; *** P<0.001

calving milk yield and composition (fat, protein and lactose) were recorded from all cows at fortnightly intervals until the termination of the project in mid-December 1990.

The trial data was analysed as a split-plot ANOVA using the SAS statistical programme.

RESULTS

Age Effects on Liveweight Gain

In seven of the eight years the age effect on liveweight gain from early June to calving was highly significant (P<0.01) (Table 1). A summary of the analysis (Table 2) demonstrates that liveweight gain of the rising 2 year heifers was one third that of mature cows when grazing in the same herd. Breed and liveweight at the commencement of winter had little effect on liveweight gain. Calving date had a highly significant effect and was the result of the later calving cows having a greater liveweight gain than earlier calving cows. Stocking rate was a significant factor in four of the eight years. The stocking rate by age by breed interaction was the result of the Jersey x Friesian rising 2 year heifers having a lower liveweight gain at the higher stocking rate than the Jerseys.

Age Effects on Production

Age and breed were significant factors affecting milk solids production (Table 3). Heifers produced 23% and 25% less milkfat and protein respectively than mature cows and crossbreeds produced 3% more milkfat and protein than purebred Jerseys.

Liveweight and cow condition at calving were also significant factors affecting milk solids production (Table 4). However for milkfat production the relationships with liveweight or cow condition were significantly different for heifers and mature cows, showing that heifers were more responsive in milkfat production to increasing liveweight at calving than mature cows. A similar trend was observed for protein production but the age effect was not significant (P<0.07). Liveweight gain from June to calving was not significantly associated with milk solids production although for milkfat and total milk solids production there was a significant age by liveweight gain interaction, with the heifers showing a positive and the older cows a negative association.

TABLE 2 Age effect in a mixed age herd on liveweight gain over winter.

Age	Average cow liveweight (kg) June 1	Calving	LW gain
2 Year	310	318	8
3 Year	326	359	32
Mature	385	418	33
Significance			**

** P<0.01

The model developed incorporating the variables; year, stocking rate, breed age, liveweight and condition explained 68-72% of the variation in milkfat and milk

protein production respectively. The greatest proportion of the variation was attributed to year, stocking rate and a year by stocking rate interaction. The effects presented in Table 4 on the relationships between liveweight and condition at calving, although highly significant, accounted for less than 2% of the total variation in milk solids production.

TABLE 3 Age and breed effects on average fat and protein production.

		Fat (kg/cow)	Protein (kg/cow)
Age:	2 Year heifers	142.5	101.5
	Mature cows	175.3	126.8
	Significance	**	**
Breed:	Jersey	156.5	112.4
	Jersey x Friesian	161.4	115.9
	Significance	**	**

** P<0.01

Field Trial

Herbage mass levels before and after grazing and rates of DM disappearance for the three treatments were similar over the trial period showing that the management objectives to graze the three treatments in a sumilar manner were achieved.

The liveweight gain of heifers and cows grazed separately was significantly greater than that recorded for heifers grazed with mature cows (Table 5) or for mature cows grazed separately or with heifers. The effect was however significantly greater for the heifers than the mature cows. Milk solids production to December and liveweight in December (Table 5) was similar within age groups for each of the winter management treatments showing clearly that the benefits gained in heifer and cow liveweight from separate grazing had no effect or milk solids production or final liveweight. Figure 1 shows for the heifers that the advantage in liveweight at calving to the separately grazed group was lost within a month after calving. Milkfat production for the first three tests after calving tended to be lower for the heifers wintered separately but by mid-November was similar for both treatments.

DISCUSSION

Farmers have believed that rising two year heifers do not perform well when wintered with the whole herd. To avoid the apparent competitive effects on the heifers it is common to winter the herd in two mobs; usually rising two year olds, three year olds and skinny cows in one mob and mature cows in another. Occasionally the rising two year olds only are wintered in a separate herd. The effects of these wintering systems on heifer/cow competition, liveweight gain and subsequent production has not previously been reported.

TABLE 4 The relationships (regression coefficients) between liveweight and condition at calving and milk solids production for two year heifers and mature cows.

	Liveweight	Condition	L.Wt gain June-Calving
Milkfat production			
2 Year	0.22	9.72	7.51
Mature	0.07	2.08	-8.93
Age effect	**	**	**
Milk Protein			
2 Year	0.15	7.44	-5.80
Mature	0.10	3.60	3.63
Age Effect	NS	NS	NS
Total Milk Solids			
2 Year	0.4	17.0	11.1
Mature	0.2	6.0	-14.7
Age Effect	**	NS	**

N.S Non significant; ** P<0.01

In the analysis of eight years data from a herd wintered as a single mixed age herd it was found that liveweight gain of the rising two year heifers was only one third that of the older cows (Table 1). Liveweight of the heifers remained reasonably constant in the year after joining the herd. Liveweight gain in the subsequent winter of rising three year olds was similar to that of mature cows suggesting that cows of this age were fully adjusted to the herd environment. Rogers *et al.* (1979); Grainger *et al.* (1982) and Morton and Jensen (1990) reported that liveweight, or condition of mature cows at calving is a significant factor affecting subsequent

TABLE 5 Performance of cows and heifers wintered either separately or as one herd.

	HEIFERS		MATURE COWS	
	Separate	One herd with cows	Separate	One herd with Heifers
Liveweight gain, kg/cow (June 20 - Calving)	24.5	3.8	13.3	7.9
L.S.D Heifers, cows (P<0.01)	6.47		4.54	
L.S.D Interaction (P<0.01)		7.80		
Milk solids prod, kg/cow calving - 14 Dec (116 days)				
Fat	72	77 NS	84	89 NS
Protein	52	54 NS	63	68 NS
Liveweight kg/cow 14 Dec	358	359 NS	418	418 NS

milkfat production. The effect of liveweight on milkfat production published by these authors has been variable, from 0.1 kg fat to 0.3 kg fat/kg liveweight increase. Macmillan and Bryant (1980) from an analysis of survey information from 31 Waikato herds reported a similar response to condition at calving for rising two year heifers and three year olds but no effect of condition score on production of mature cows.

The results presented in Table 4 on the relationships between liveweight, condition and milk solids production for rising 2 year heifers are within the range of relationships published and support the conclusions drawn by Macmillan and Bryant (1980) that young cattle are more responsive than older cattle to increasing liveweight at calving. Thomas and Mickan (1987), from a survey of commercial herds in Victoria, Australia, found that the relationship between liveweight at calving and milkfat production was significant for Friesian heifers (0.25 kg fat/kg liveweight) but not for Jersey's. The authors reported that variation in liveweight at calving accounted for only 8% of the variation in milkfat production and concluded that, provided heifers are sufficiently grown to conceive, their milk production in the first lactation will not be substantially affected by size at calving. The data reported here shows that liveweight at calving explained less than 2% of the total variation in milk solids production. Firm conclusions cannot be drawn from this type of analysis but there are indications that milkfat production from rising two year heifers is more sensitive to liveweight at calving than for mature cows.

The nil effect of liveweight gain from June to calving on milk solids production is contrary to previous published reports which have shown that an increase in liveweight gain over winter is associated with an increase in milkfat production (Morton and Jensen, 1990). This suggests that conclusions from component studies on the association between winter liveweight gain and subsequent milk solids production may be different when the total system is considered. No explanation for this can be given other than the suggestion that herd behaviour may differ between whole herd systems and trial herd comparisons.

In the field trial, heifers and cows wintered in a separate herd gained 20.7 kg liveweight and 5.4 kg liveweight respectively more than heifers and cows wintered in a mixed age herd (Table 5). This difference in liveweight however resulted in no increase in milk solids production over the first 116 days of lactation for both age groups. After calving the heifers and cows wintered separately were grazed as one mixed age milking herd. The reason for the nil response could possibly be because it takes time following the introduction of new animals to a herd to re-establish herd hierarchy but does however confirm the lack of association between liveweight gain over winter and

milk solids production observed in the analysis of the database. The level of feed shortage after calving, as demonstrated by the low fat production/cow in Figure 1, was severe and this may have aggravated inter-animal competition. It appears however from Figure 1 that the apparent competitive effects of within herd competition was negated by mid-November.

The information presented highlights the need for further information on the effects of wintering systems on the performance of cows of different ages and a greater understanding of cow and herd behaviour, especially those associated with the introduction of young or minority groups to a herd. With a better understanding of these factors increases in milk solids production may be achieved with little or no increase in feed (pasture) cost.

Liveweight and milkfat production from heifers

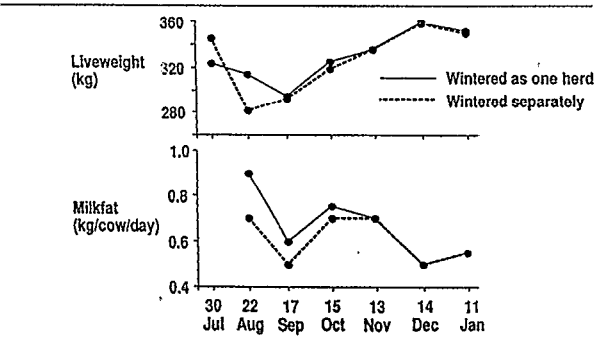

FIGURE 1: Liveweight and milkfat production for heifers; from calving to December.

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