Productive and reproductive efficiency of two Holstein Friesian lines of cows which differ genetically for live weight

Daniel Laborde

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Abstract

Two lines of Holstein Friesian cows which differ genetically for live weight, the Light Line (LL) and the Heavy Line (HL), have been selected at the Dairy Cattle Research Unit (Massey University) since 1989. The aim of the current experiment was to compare the productive and reproductive performance of these two lines during early lactation. Measurements of milk production, liveweight (LW), and pasture intake were made in 1996, while reproductive data were analysed for 1992 to 1997.

In experiment 1a, the milk production of the two lines was compared during the first 12 weeks of the lactation by the weekly measurement of the milk yield and the milk composition of 30 LL cows (average LW= 412 kg) and 27 HL cows (average LW= 445 kg), with the two groups of cows fed and managed identically. Pasture dry matter intake (DMI), calculated as pasture disappearance, was 13 to 15 kg DM a day during these 12 weeks. Although the HL produced slightly more milksolids (MS) than the LL, the difference was not significant (LL= 139 vs HL= 141 kg MS). However, the HL cows > 2 year old produced 7 kg MS more than the LL cows > 2 year old ($P<0.05$). The LW and body condition score (BCS) changes in cows after calving were similar for both lines, but in the heifers the LL lost 17 kg of LW during the first 5 weeks of lactation compared to the HL that maintained their LW ($P<0.05$). Similarly, the BCS of the LL was lower than that of the HL at 40 days postcalving (LL= 4.17 vs HL= 4.43, $P<0.05$) mainly due to the BCS lost by the LL heifers.

In experiment 1b, the DMI and the dry matter digestibility (both estimated using the alkanes technique) of 21 LL cows (406 kg) and 21 HL cows (482 kg), grazing at a pasture allowance of 40 to 45 kg DM/cow/day, was measured in a ten days trial. The grazing behaviour of the two lines was also recorded during 2 days. Although the LL cows ate slightly less DM (LL= 14.3 vs HL= 15.1 kg DM/cow) and had a slightly higher MS conversion efficiency than the HL cows (LL= 120 HL= 110 g MS/kg DM eaten), the differences were not significant. When DMI was regressed on $LW^{0.75}$ and MS yield, the effect of $LW^{0.75}$ only approached significance ($P<0.1$), but the effect of MS was highly significant ($P<0.001$). The two lines had similar DMD (LL= 77.8% vs HL= 78.0%), gross energy conversion efficiency (LL= 44.6% vs HL= 42.3%) and net energy conversion efficiency (LL= 64.8% vs HL= 64.6 %). The bite size of the HL cows (estimated from the grazing time, biting rate and DMI) was heavier than that of the LL cows (LL= 0.46 vs HL= 0.60 g DM/bite, $P<0.01$), but the LL cows compensated for their lighter bite size by increasing the number of bites per minutes (LL= 55 HL= 50 bites/minute, $P<0.05$).

The reproductive performance of the two lines was compared for the period from 1992 to 1997, and the interval Calving-Ovulation was estimated from the concentration of progesterone in milk in 1996 and 1997. The HL cows had shorter calving-ovulation intervals than the LL cows (LL= 32 vs HL= 28 days, $P<0.05$), but the difference in calving-first heat interval was not significant (LL= 43 vs HL= 50 days). Compared to the LL cows >2 year old, the HL cows > 2 year old tended to calve and to conceive later in the calving and mating periods, respectively, because the HL cows had a lower conception rate at first service than the LL cows (LL= 70% vs HL= 58%, $P<0.05$).

The ovaries of 10 cows from each line (LL= 405 vs kg HL= 481 kg) were scanned daily during a complete cycle before the start of mating. Cows from the HL had preovulatory follicles with larger diameter (LL= 12.7 vs HL= 15.7 mm, $P<0.05$) and corpus lutea with larger areas (LL= 690 vs HL= 859 mm^2, $P< 0.05$) than the LL cows. No differences were detected in the diameter of the first and second dominant follicles. On average, the preovulatory follicles of the HL cows achieved their maximum diameter later in the cycle compared to the LL (LL= day 18^{th} vs HL= day 20^{th}).

The results from the current experiment show that although the HL produced slightly more MS than the LL in the longer period, the two lines of cows achieved similar levels of MS yield during early lactation independently of their LW and size. Similarly, although the LL cows had a slightly higher MS conversion efficiency than the HL cows, the differences in energy and MS conversion efficiency between the two lines were not significant. The reproductive data analysed from 1992 to 1997 suggest that the LL cows achieved a better reproductive performance than the HL cows because of their higher conception rate at first service. However, more information is required from other stages of the lactation before any definite conclusion is reached about the feed conversion efficiency of the two lines. Similarly, considering the variation in the reproductive performance of the HL between the years, reproductive data from subsequent seasons must be collected in order to verify, or disprove, the current conclusions.

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TABLE OF CONTENTS.

List of Tables and Figures

Chapter One

INTRODUCTION

The suspected relationship between size of the cows and efficiency of milk production has been the topic of many studies done in the last 50 years (Brody, 1945; Mason,1957; Yerex *et al*, 1988; Holmes *et al*, 1993; Hansen *et al*, 1998). Scientists have approached this subject in two different ways: indirectly, comparing the milk production efficiency between breeds which differ in size (Blake and Custodio, 1986; Gibson, 1986; Oldenbroek, 1988; Ahlborn and Bryant, 1992), or directly, assessing the conversion efficiency of dairy cows from the same breeds, but with different size (Stakelum and Connolly, 1987; Yerex *et al*, 1988; Holmes *et al*, 1993). They attempted to find out the direction in which the size of the dairy cows has to go in order to make the systems more efficient and profitable (Robertson, 1973). However, the conclusions have been controversial (Morris and Wilton, 1976). One constraint was that efficiency ,in economic or biological terms, is not easy to define or to measure (Spedding, 1988; Holmes, 1988; Ostergaard *et al*, 1990). In addition, it is possible that the question about the "ideal" size of the cows does not have only one answer (Robertson, 1973; Holmes, 1973), it could change according to the production system in which the cows are producing (Taylor, 1973; Oldenbroek , 1988).

Milk production in New Zealand is defined as a low input pastoral system (Holmes, 1990; Bryant, 1982). It is based on a high pasture utilisation which is achieved using the appropriate stocking rate under a seasonal system of milk production (Holmes and Macmillan, 1982; Holmes, 1990). A direct consequence of using high stocking rate and maximal pasture utilisation is that each cow of the herd has available a limited amount of the pasture produced in a year, meaning that dry matter intake of the cows is constrained by pasture allowances (Poppi *et al*, 1987; Holmes, 1988). Under this scenario, because of the maintenance costs, size of the cows was identified as a component affecting the final efficiency of the dairy systems in New Zealand (Ahlborn and Dempfle, 1992; Holmes *et al*, 1993). In fact, liveweight of the cows is now given a negative weight in the final selection index of the cows in the new overall objective of increased $ of milk solids produced per tonne of DM eaten (New Animal Evaluation System, LIC, 1996). The objective was to select dairy cows in a more appropriate direction for the New Zealand conditions of production, taking into account that heavier cows have to produce more to be as efficient as a light cow (Holmes *et al*, 1993).

However, because of the existence of genetic correlation, other characteristics may be affected when selecting for or against size of the cows. For instance, some geneticists have expressed some concern about the possible negative effects that selecting against live weight may have on intake capacity and body condition score of the high genetic merit cows. It has also been reported that genetically heavy cows required more service to conceive than light cows (Hansen *et al*, 1998). There are only a few genetic studies designed to evaluate the effect of genetic differences in the LW of cows from the same breed on the efficiency of the dairy systems. In Minnesota, an experiment with 2 lines of Holstein cows which differ genetically for live weight has been running for over 30 years (Hansen *et al*, 1998), but the conditions of production are completely different to those in New Zealand. No experiment has been designed to compare in practice the efficiency of dairy cows within the same breed which differ genetically for live weight under grazing conditions. The Light (LL) and Heavy (HL) genetic lines of Holstein-Friesian cows developed at the Dairy Cattle Research Unit (DCRU, Massey University) is the first attempt to study this subject which has an especial significance for the New Zealand conditions of production. The present experiment was designed to compare the dry matter intake, milk production , feed conversion efficiency, grazing behaviour and reproductive performance during early lactation of the HL and LL lines of cows.