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Feed intake capacity in Holstein-Friesian cows which differed genetically for body weight

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ABSTRACT

The feed intake capacity (FIC) of pregnant, non-lactating Holstein-Friesian cows, selected for either high (H) or low (L) breeding values for live weight (LW), was measured when fed to appetite on hay (7.5 MJ ME/kg DM in 1998) and on pasture (11.1 MJ ME/kg DM in 1999). The H cows were heavier than the L cows in both years (546 v 482 kg; 540 v 464 kg in years 1 and 2 respectively), and the H cows ate significantly ($P<0.01$) more feed than the L cows in both years (12.5 v 11.1 kg hay DM, and 13.1 v 11.6 kg pasture DM per day in years 1 and 2 respectively. Regression analysis showed that for each 100-kg increase in LW, daily DMI per cow increased by 1.43 and 1.81 kg respectively in 1998, and 1999. Regression analysis of the data after conversion into $\log_{10}$, showed that DMI was proportional to $LW^{0.66}$ and $LW^{0.65}$ in 1998 and 1999 respectively. These results indicate that the genetically heavier cows ate more DM than the genetically lighter cows. Nevertheless, the difference between maintenance costs and FIC (or "net" FIC) may be similar for both strains, so that the smaller intake of the lighter cows does not disadvantage their productive capacity.

Keywords: dry matter intake; live weight; breeding values; alkanes; dairy cows.

INTRODUCTION

The trait live weight (LW) has recently been included, with a negative economic value, in the New Zealand Dairy Industry genetic index, Breeding Worth. The negative economic value attached to LW reflects its effect on the maintenance feed cost of the individual, and therefore on its total energy requirement and feed conversion efficiency. It also takes into account its effect on the carcase value of culled animals.

In lactating cows, LW is positively related to feed intake capacity (FIC) but negatively related to feed conversion efficiency Persaud *et al.* (1990; 1991). The inclusion of both traits in a genetic selection index was reviewed by Veerkamp (1998). FIC is generally related to some function of LW between 0.4 and 0.8, although there are no data for cows that were genetically different in LW (Forbes, 1996; Kleiber, 1965). Energy cost for maintenance is generally related to LW to the power of 0.6 to 0.8. Therefore, the difference (FIC – maintenance cost), which will determine the cows' productive ability, may also be similarly related to LW, but this is not known.

The present study used cows that were known to differ genetically in LW to measure the relation between LW and FIC. It was part of a larger programme to study the effects of genetic selection for LW on efficiency of dairy cattle (García-Muñiz *et al*., 1998).

MATERIALS AND METHODS

Animals

Experiment 1 (EXP1) (n=16) and experiment 2 (EXP2) (n=24) were carried out with pregnant non-lactating cows, with half of the cows chosen from the heavy (H) strain and half chosen from the light (L) strain (García-Muñiz *et al.*, 1998) and balanced for age at the beginning of each experiment. In EXP1 the animals were housed indoors, in individual stalls and 13 days were allowed for stabilization before a measurement period of 19 days during the winter (June-July) of 1998. In EXP2 the cows were rotationally grazed as a single group for 16 days, which included the stabilization period and the 10-day measurement period.

Feeds and Feeding

In EXP1, sufficient hay (7.5 MJ ME/kg DM) was offered to each cow to ensure that 10% was left uneaten each day. The daily quantities ranged between 13 to 24 kg DM/cow.

In EXP2, the cows were offered a generous daily herbage allowance of about 30 kg DM/cow as assessed by a rising plate meter (Ashgrove Pastoral Products, Palmerston North, New Zealand). Mean values for pre and post-grazing herbage masses were: 3227 kg DM/Ha and 1174 kg DM/Ha and the average apparent herbage intake was 11.2 kg DM/cow daily, by all cows. The herbage contained 11.1 MJ ME/kg DM.

Measurements recorded

In both experiments LW and body condition score (BCS) of the cows were measured at the start and at the end of the trials.

In EXP1, the quantity of hay offered to each cow and the refused hay were weighed and their DM concentration measured. DMI by each cow was measured directly, as the difference between the weights of hay DM offered and the weight of hay DM refused each day. The digestibility of the hay offered was measured *in vitro* (Roughan & Holland, 1977).

In EXP2, herbage intake of individual cows was assessed using the *n*-alkane technique Dove & Mayes (1991); Dove *et al.* (1996). Each cow was given an alkane capsule marker with a nominal release rate of 400 mg (FERNZ NZ Ltd). After a six-day stabilization period, faecal and grass samples were collected during at least the first three days of each of two 5-day sampling periods and then frozen at -20 ºC. Grass samples were freeze-dried and faeces were oven dried at 60 ºC for 24 hours and pooled within each of the two collection periods. The *n*-alkane concentrations of the samples from the two periods were averaged and DMI was estimated from the concentration of C_{33} (natural odd-chain) and C_{32} (dosed even-chain) alkanes in the pasture and faeces respectively, as described by Dove & Mayes (1991). The concentrations of alkanes were measured by R. McKee at Dairying Research

Corporation. Dry matter digestibility (DMD) was predicted from NIRS analysis (Corson *et al.* 1999) and the equation described by Geenty & Rattray (1987).

The data were transformed to logarithms (Log_{10}), and were then subjected to simple linear regression analysis, and to analysis of variance using PROC GLM.

RESULTS

The least-squares means of some variables are listed in Table 1. The difference between the strains in LW and DMI per cow per day was highly significant (P<0.01), after adjustment for parity number in both years 1998 and 1999. The H cows ate 12.5 kg DM of hay and 13.1 kg DM of pasture in 1998 and 1999 respectively, while the L cows consumed 11.1 kg DM of hay and 11.6 kg DM of pasture in 1998 and 1999 respectively. As expected, DMI per cow increased as LW increased. For each 100-kg increase in LW, DMI/cow/day increased by 1.43 and 1.81 respectively in 1998, and 1999.

TABLE 1: Least squares means for BCS, LW, metabolic LW ($LW^{0.75}$), liveweight change (LWC), and DMI adjusted by lactation number for each genetic line recorded during experiments one and two in 1998 and 1999 respectively.

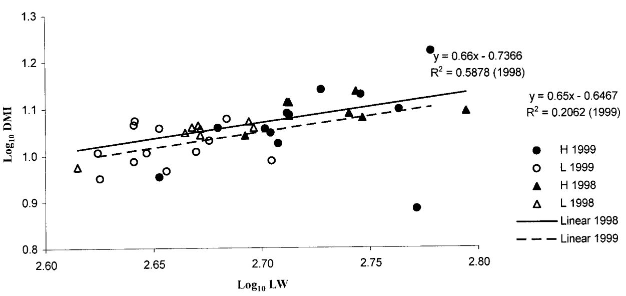
Parameter	1998			1999		
	H	L	Signific[2]	H	L	Signific[2]
n[1] (cows)	8	8	-	12	12	-
BCS	4.5	4.5	NS	4.5	4.6	NS
LW (kg)	546	482	***	540	464	***
$LW^{0.75}$	113	102	***	112	99	***
LWC (kg/day)	-0.01	-0.03	NS	0.81	0.65	NS
DMI (kg/cow/day)	12.52	11.11	**	13.10	11.63	**

[1]n: number of observations

[2]Significance: NS not significant; † P<0.1; *P<0.05; **P<0.01; ***P<0.001

The relations between $\log_{10}$ DMI and $\log_{10}$ LW are shown in Figure 1; DMI increased in proportion to $LW^{0.66}$ in 1998 and $LW^{0.65}$ in 1999. These show that an increase of 100 percent in LW was associated with an increase of 66 and 65 percent in DMI for 1998 and 1999 respectively.

FIGURE 1: The relation between $\log_{10}$ dry matter intake (DMI) and $\log_{10}$ live weight (LW) for the genetically heavy (H) and light (L) cows in 1998 and 1999



DISCUSSION

The present results agree with those reported by Dean, (1998); Garcia-Muñiz *et al.* (1998) and Laborde (1998, unpublished) carried out with H and L cows fed *ad-libitum* on pasture or hay. After adjusting for differences by parity number of each genetic line (see Table 1), there were significant differences in DMI (P<0.01) between H and L cows either fed indoors on hay or grazing on pasture in 1998 and 1999. The least-squares means for DMI/cow/day for H and L cows were 12.81 and 11.37 respectively, with a difference of 11.2% per cow. These results suggest a positive genetic correlation between LW and feed intake as reported by Veerkamp *et al.* (1999), suggesting that heavier animals consume more feed and may, therefore, be less efficient than lighter animals Persaud *et al.* (1990 & 1991).

The pasture DMI measured by the alkane technique was similar to the values reported by other authors working with lactating cows at similar pastures allowances Glassey *et al.* (1980); Bryant (1980); Peyraud *et al.* (1996). The effect of LW on DMI in the present experiments is also similar to the effects reported by other authors (Stakelum & Connolly, 1987; Laborde, 1998 unpublished; Garcia-Muñiz *et al.*, 1997; Yerex *et al.*, 1988). Feed intake increased in proportion to the 0.65 to 0.66 power of LW, exponents which are higher than the power of 0.41 found by Dean (1998, unpublished) for a similar study with cows from these groups fed on hay, but slightly lower than the conventional 0.75 power often used (Forbes, 1996; Kleiber, 1965).

Maintenance cost also increases with increase in LW, and a power of 0.75 is often assumed for this relation, an assumption that has been supported by unpublished measurements in the present studies (Ramirez, 2000). The real significance of the present data is that they suggest that as LW increases, FIC also increases but at a rate slower than the rate at which maintenance costs increase. Therefore "net" FIC (total FIC – maintenance costs) probably does not increase with increases in LW, and it may even decrease. If this is true, it means that inclusion of LW, with a negative economic value, in genetic selection indexes would not be expected to lead to decreases in "net" FIC.

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