

Experience with Data Recording and Genetic Evaluation of Live Weight for Dairy Cows in New Zealand

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Summary

Recording weights of lactating cows from weighing scales has been undertaken extensively for the New Zealand national genetic evaluation system for dairy cattle since 1993. The purpose of the recording scheme has been to enable feed demands associated with body size to be accounted for in assessing the economic merit of dairy bulls and cows. The recording scheme is described, together with the statistical model for the genetic evaluation of dairy cow mature live weight. Future methods for recording live weight and future uses of live weight data are discussed.

Introduction

Live weight has been proposed as an important functional trait of dairy cows, due to the well recognised dependency of feed demands for body maintenance on metabolic live weight (Groen, 2000). Internationally, motivation for recording live weight has been reduced by concerns that selection goals that include both increasing yield and restraint on increasing live weight might be associated with undesirable correlated responses (Koenen, 2002; Veerkamp, 1998). These concerns are based on genetic parameters derived from Northern Hemisphere populations, some of which do not hold for New Zealand populations (Pryce and Harris, 2006). The studies do not address the opportunities that exist for farmers to make use of variation in feed conversion efficiency between dairy breeds as well as variation within breeds (Grainger and Goddard, 2004).

In the New Zealand farm production circumstances farmers identified the need for both genetic and management information on the economic efficiency cows of different breeds in their herds. Two of the parent breeds – Holstein-Friesian and Jersey – differed in mature live weight by a factor in excess of 25%, at the same level of body condition.

Data recording of conformation traits to extrapolate body size differences has been undertaken in a number of countries. In New Zealand it was not clear that the body size data from the conformation recording system conducted on first parity heifers was adequate for the purpose of comparing the economic efficiency of dairy cows and sires with the accuracy demanded by farmers.

Data recording

Over 850,000 live weights, recorded on scales in kilograms, for mixed age cows are extracted for use in genetic evaluation of mature live weight. Pre-edits for the genetic evaluation system requires that these records have been matched to an identified lactating cow with a recorded breed, date of birth, and a calving date and milk performance record obtained in the same lactation as the live weight record.

The system also uses inspector scores for live weight of two-year-old heifers that are obtained as part of the conformation recording system.

Scale weight recording is undertaken in the progeny testing herds of the main AI companies to enhance accuracy of bull proofs. Farmers who want the information on their own cows for management and evaluation purposes also obtain live weight records, and transmit them to the national database. This farmer recording activity was widely undertaken in the mid 1990s, but has declined in recent times. Farmers' live weight recording activity has reduced because progress in weighing technology has not matched the doubling in the cow numbers that each farmer manages, which has occurred in the past fifteen years in New Zealand. In addition, contractors' costs for conducting weighing have more than doubled in recent years. Figure 1 shows the trend in the number

of recorded live weights on weighing scales for the past fifteen years.

Evaluation model for live weight

The animal model used for live weight is a repeated record, single trait, additive genetic effects model. The statistical model is:

$$y_{ijklmno} = hsa_i + \sum w_r h_r + s_{jk} + ab_{lm} + \sum q_r g_r + a_n + p_n + e_{ijklmno}$$

where:

$y_{ijklmno}$ is the live weight record o for animal n in herd-year-season-age contemporary group i at stage of lactation class j of age class k and in age at first calving class l and of breed m ;

h_{sai} is the fixed effect for herd-year-season-age contemporary group i ;

s_{jk} is the fixed effect for stage of lactation when the cow was recorded j nested within age class k ;

ab_{lm} is the fixed effect for age at first calving l nested within breed m ;

w_r is the contribution of heterosis breed class r of animal n ;

h_r is the fixed effect for heterosis r ;

q_r is the contribution of genetic group r to the genetic merit of animal n ;

g_r is the fixed effect for genetic group r ;

a_n is the random additive genetic effect for animal n ;

p_n is the random non-additive genetic and permanent environment effect for animal n ;

$e_{ijklmno}$ is the random residual.

Stage of lactation is nested within age to account for different growth curves for younger cows compared to mature cows. Age at calving is nested within breed to account for different maturity rates for different breeds.

For dairy sires, and for cows, the analysis generates estimated breeding values for mature live weight of cows that are comparable across breeds. For cows the analysis also generates a “liveweight production value” ($\sum w_r h_r + \sum q_r g_r + a_n + p_n$) that is used for the cow profitability index known as Production Worth. The Production Worth index is used by farmers for comparing cows of different breeds, different live weights and different production levels for their efficiency in converting feed into net farm income.

Results of the live weight evaluation

Summary statistics for estimated breeding values for female mature live weight of recently progeny tested AI dairy sires are reported in Table 1. Mean reliabilities of these estimated breeding values is 80%. The data show that average Holstein-Friesian mature cows are more than 25% larger than average Jersey mature cows.

Discussion

New Zealand dairy cows perform in pasture based production systems, with limited buffering against shortage of pasture quantity or quality achieved with low cost forage supplements. The production systems have evolved in response to milk and grain prices that rarely make feed grains a profitable component of milking cow diets. Milk volume is a cost item for the farmer, because the objective of the dairy processors is to manufacture dairy products to supply distant markets – into which supply of liquid milk is prohibitively expensive. Farmers monitor cows’ yields in terms of milksolids (combined protein and milkfat). In this context it is noteworthy that a large proportion of milk production from European and USA dairy farms is supplied for manufacturing rather than liquid milk – in the order of 75% for Europe and 70% for USA (Anon, 2006a).

Recorded New Zealand production performance in 2006 for just over 1 million milk recorded Holstein-Friesian cows was 328.6 kg milksolids per lactation, and 328.2 kg

milk solids for just under 0.75 million recorded Holstein-Friesian \times Jersey crossbred cows (Anon, 2006b). The live weight data for recorded cows indicates that the Holstein-Friesian cows are 45 kg heavier than the crossbred cows. At this level of analysis the crossbred cows are achieving the same output as the Holstein-Friesian cows, while requiring in the order of 1,500 fewer megajoules of metabolisable energy annually for body maintenance. A plausible implication is that the three quarters of a million crossbred cows are saving a vast amount of the industry's feed resource – in the order of 100,000 tonnes of dry matter in good quality pasture annually.

In these production circumstances the number of crossbred replacements reared now exceeds the number of straightbred replacements from the heavier parent breed. Without credible live weight recording and analysis farmers would not have the tools to make decisions about the gross feed conversion efficiency potential of their replacement heifer calves.

Future requirements

The cost/benefit ratio associated with weight recording will reduce if less labour intensive systems for recording live weight become available. New developments enable weights to be automatically recorded without the need to stop animals from proceeding in their normal single file movement as they exit the yards or the milking facilities (www.tru-test.com/weighing_new/wow.asp, www.gallagher.co.nz/weigh_systems.aspx).

This technology has the potential to generate large quantities of useful data for both farm

management purposes and for assessing important characteristics of animals.

The recording practices would be readily extended to obtain useful data from animals before they enter the dairy herds. In this case useful information for both bulls and heifers could be generated – particularly in the context of a New Zealand beef industry that features many animals originating from dairy herds.

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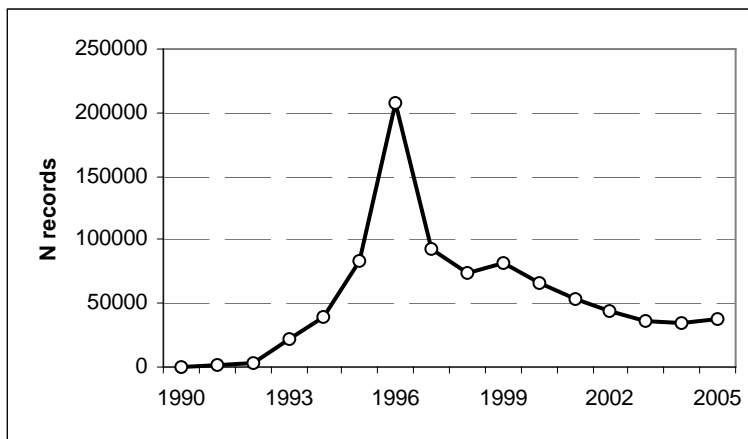


Figure 1. Trend in quantity of live weight scale recording in New Zealand 1990-2005

Table 1. Sire statistics for recently progeny tested sires in New Zealand for estimated breeding values of female mature live weight (kg).

	N	Mean BV (kg)	StDev BV	Min BV	Max BV	Mean recorded daughters
All breeds	4947	38	57	-96	142	145
Ayrshire	517	31	23	-35	106	61
Holstein-Friesian	2666	82	22	12	142	154
Jersey	1375	-42	16	-96	7	184
Crossbred	248	16	24	-47	83	72
Other	141	44	21	-5	105	22