USE OF GENETIC INFORMATION ABOUT THE HERD IN THE DESIGN AND MANAGEMENT OF DAIRY FARM SYSTEMS

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ABSTRACT

The aim of this thesis was to find ways of using the genetic information available about the cows to assist in improving the management of the herd and replacements. In particular models were developed which used Estimated Breeding Values to determine the feed demand of the cow and target liveweights for replacement heifers. The relationships between estimated breeding values (EBV) and cow performance at a range of feeding levels, and the effect of genetic merit on the partitioning of feed to milk or liveweight gain throughout the lactation, were also investigated.

At low levels of feeding, the absolute differences in milk yield between cows corresponded to the absolute differences in breeding values between cows. However, at high levels of feeding the difference in milk yields between genetic groups are greater than the difference in breeding values. This constitutes a form of genotype x environment interaction, which has important practical and economic implications for dairy farms, and for the expected value of genetic improvements.

High genetic merit (HGM) cows partitioned a significantly higher proportion of metabolisable energy intake into milk than low genetic merit (LGM) cows in early (0.68 vs 0.62), peak (0.59 vs 0.57), mid (0.58 vs 0.56) and late lactation (0.53 vs 0.51) (HGM vs LGM respectively). In early lactation, HGM cows utilised more body reserves for milk production (-0.06 vs –0.004, for HGM and LGM, respectively). In addition, HGM and LGM cows appeared to compensate for low intakes in early lactation by reducing the level of MEI partitioned to milk, which probably prevented excessive weight losses. These results with grazing cows confirm published data with cows fed on other rations.

Results from a grazing experiment, with 5 separate farmlets at 5 different stocking rates, were used to provide genetic information and performance per cow of a "calibration" herd corresponding to maximum profitability per farm (max EFS). The genetic and performance information for the calibration herd was then used to predict the performance of other cows or herds based on the difference in EBV for liveweight and milksolids. From these predicted values for liveweight and milksolids the "Genetic Feed Demand" (GFD) of the herd was calculated at max EFS. The GFD can then be used to adapt and improve the Comparative Stocking Rate (CSR) equation by replacing kg liveweight/ha with total GFD. Optimum values for the new CSR of 0.7 to 0.8 are proposed. This simple adjustment using genetic values provides a better estimate of the

feed demand of the herd. From this an appropriate number of cows for the specified feed supply can be determined

Another model was developed to use the liveweight EBV to formulate a set of liveweight targets for individual heifers of any breeds at different ages throughout the first two years of their life. Feeding regimes for the heifers were also proposed. A heifer herd management report was outlined that could be used by farmers and graziers to focus special attention on those individual heifers which were significantly lighter or heavier than their target weights for age.

In conclusion, greater use should be made of genetic information of individual cows and herds when designing and managing dairy farm systems. Genetic values can be used in a number of ways to ensure cows or heifers are fed more appropriately so they achieve levels of performance, which are closer to their pre-determined genetic potential. Genetic information should also be included in tools that are used to model the management of dairy farm systems, as this will improve the accuracy of prediction.

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LIST OF ABBREVIATIONS

Abbreviations

kg	Kilogram
DM	Dry matter
Lwt	Live weight
DIM	Days in milk
MS	Milksolids
ME	Metabolisable energy
MEI	Metabolisable energy intake
MJ	Mega joule
M_m	Metabolisable energy requirements for maintenance
M_l	Metabolisable energy requirements for lactation
M_c	Metabolisable energy requirements for pregnancy
M_g	Metabolisable energy requirements for liveweight gain
M_{g-l}	Metabolisable energy spared from liveweight lost
EP_m	Proportion of energy partitioned to maintenance
EP_l	Proportion of energy partitioned to lactation
EP_g	Proportion of energy partitioned to liveweight change
HGM	High genetic merit
MGM	Medium genetic merit
LGM	Low genetic merit
HF	Holstein-Friesian
J	Jersey
A	Ayrshire
HF/J	Holstein-Friesian/Jersey cross
J/A	Jersey/Ayrshire cross
HF/A	Holstein-Friesian/Ayrshire cross
EBV	Estimated breeding value
PTA	Predicted transmitting ability
BW	Breeding worth
LwtEBV	Liveweight estimated breeding value
GxE	Genotype by environment interaction
PROC	Procedure
SAS	Statistical Analysis System
GFD	Genetic feed demand
EFS	Economic farm surplus
CSR	Comparative stocking rate
max EFS	Maximum economic farm surplus per farm

Statistical terms

*	Significant at $P < 0.05$
**	Significant at $P < 0.01$
***	Significant at $P < 0.001$
SED	Standard error difference
NS	Not significant