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

A thesis presented in partial fulfilment
of the requirements for the degree of
Master of Science majoring in Animal Science
at
Massey University
Palmerston North
New Zealand

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2003
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.
ACKNOWLEDGEMENTS

I would like to acknowledge the efforts and input of many people who made the completion of this thesis possible. Special thanks to my supervisors Professor Colin Holmes, Dr Nicolas Lopez-Villalobos and Dr Ian Brookes.

Colin Holmes spent untold hours reading and promptly returning drafts, and I hope to give him a break from reading drafts for a while. He always made himself available, and provided many ideas that enriched this thesis. His detailed knowledge of dairy systems proved extremely valuable.

Thanks also to Dr Nicolas Lopez-Villalobos who had many ideas that he challenged me to develop, he was always willing to help, and reined me in when I got ahead of myself. His comprehensive knowledge of genetic evaluation, statistical analysis, and modelling was particularly valuable. To Dr Ian Brookes, thanks for helpful comments and information relating to the calculation of feed requirements.

I would also like to acknowledge the efforts of Kevin Macdonald at Dexcel, and Graeme Pitman at the Stratford Demonstration Farm, who provided information, which has been included in this thesis. The funding provided by the L.A. Alexander Trust, the J.E. Prestige Trust, AGMARDT, Dexcel and the Large Herds’ Association, allowed me to continue my studies and without their contributions I would have given up long ago.

Thanks also to fellow post-graduates and friends who provided time-outs, especially Rao Dukkipati for his interesting discussions relating to the merits of the Indian and New Zealand cricket teams.

To my parents, Ralph and Raewyn, thanks for providing a loving and grounded upbringing, and for the financial support you have provided me throughout my studies. Thanks also to my sisters, especially Andrea who was always there when I needed a break.

I would like to give special thanks to my best friend and wife Michelle, for providing love, encouragement, and financial support throughout my studies, and also for her help in the proof reading of this thesis.
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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