UTILISATION OF MARKER ASSISTED SELECTION IN THE NEW ZEALAND DAIRY INDUSTRY

A thesis presented in partial fulfilment of the requirements for the degree of
Master of Agricultural Science
in Animal Breeding and Genetics
at Massey University

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1995

ABSTRACT

The genetic and economic benefits of marker assisted selection (MAS) to the New Zealand dairy industry were evaluated. The genetic marker was assumed to be the additive quantitative trait loci (QTL) itself and thus no recombination existed between the marker and QTL. Three sizes of QTL were evaluated; 0.1, 0.3 and 0.5 genetic standard deviations (σ_G), at three starting QTL frequencies; 0.01, 0.10 and 0.35. Three MAS strategies were evaluated and compared to the current New Zealand breeding scheme that had no genotypic knowledge of the QTL (control). The economic benefits, for the three MAS strategies, were calculated from the returns of extra milk produced, resultant from superior rates of increase in QTL frequency, less the costs of identifying the QTL linked genetic markers and subsequent genotyping.

The size of the QTL had a major effect on the economic viability of the MAS strategies. For a 0.1 σ_G QTL, the most profitable strategy to utilise the QTL was to ignore it and continue with the current breeding scheme. For a single additive QTL of size 0.3 σ_G, it had to be at the 0.35 starting frequency for the MAS strategy of progeny testing only homozygous and heterozygous QTL bulls, to be more profitable than the current breeding scheme. This same MAS strategy at the 0.5 σ_G sized QTL was the most profitable for the range of QTL starting frequencies evaluated.

The MAS strategy where only homozygous QTL bulls were progeny tested, was not economically viable for any of the QTL sizes and frequencies. This was due to the reduced selection differential on the cow to bull and bull to bull pathways. The third MAS strategy investigated utilised the current breeding scheme but included knowledge of the QTL genotype for the active cows and bulls. Superior rates of genetic gain were achieved at all QTL sizes and frequencies, but it was only economically profitable for a 0.5 σ_G QTL with a starting frequency of 0.35. Selection on large QTL with this strategy resulted in short-term genetic gain, but long-term loss. This was due to less selection intensity being applied to the quantitative background, in comparison to the control.

MAS is a long-term selection strategy as the earliest returns from extra milk production, were received ten years after the selection decisions on bulls entering the progeny test system were made. The increase in the QTL frequency was not immediate and thus the benefits of the increased QTL frequency were received in the later years of analysis.

The size and frequency of the QTL have to be ascertained before a decision on how to utilise the QTL can be made. The use of MAS in the present New Zealand breeding scheme may be profitable for a single additive QTL of size 0.5 σ_G, with the degree of profitability being influenced by the starting QTL frequency.

Further study is required on the effect of; dominant QTL, multiple QTL, recombination between marker and QTL, use of multiple ovulation and embryo transfer and the utilisation of MAS in breeding schemes other than those based on progeny testing.

ACKNOWLEDGMENTS

I would like to thank my supervisors, Professors D.J. Garrick and H.T. Blair for their excellent guidance provided during the course of the study.

I gratefully acknowledge the opportunity given by Livestock Improvement Corporation, in particular Doctor Brian Wickham, to further my education. The financial and technical support provided by Livestock Improvement is appreciated, as is the financial assistance from Massey University's Scholarship Committee.

Finally, special thanks to my parents for their support and encouragement through-out my education.

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