A Genetic and Economic Evaluation of Lactose in the New Zealand Dairy Industry

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Abstract

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Milk composition in New Zealand is heavily influenced by the selection for Breeding Worth (BW) and the breed composition of the national herd. Under selection for BW a greater emphasis is placed upon protein (39% of emphasis) than fat yield (13% of emphasis) with a penalty on milk volume (14% of emphasis). The export orientated product portfolio influences the development of economic values for fat and protein in the BW, to date lactose has not been considered despite its importance in the manufacture of whole milk powder (WMP). The milk produced on farm is in deficit for lactose based on the current export product portfolio. This thesis evaluated the potential of altering New Zealand milk through the modification of the selection objective around milk lactose selection. Genetic parameters were estimated including lactose yield to construct selection objectives and indices to evaluate the effect on lactose production under a number of different product portfolio scenarios. Genetic parameters were estimated from daily and total milk records with moderate heritabilities found for both lactose yield and lactose content. The genetic correlations between lactose yield and milk volume was estimated to be 0.98, which is a potential problem as this correlation effectively gives lactose a negative economic value due to the negative value on milk volume. Using an existing industry milk processing model, the lactose deficit was estimated to be 129,000 tonnes in 2012 which is consistent with industry records. A genetic gains model developed from this thesis, combined with an existing industry model estimated that the deficit in lactose would increase by 60%, to 204,000 tonnes by

2022 if no changes were made to the current selection objective and index. Including lactose yield in the selection objective with an economic value of $2.04, 14.7% relative emphasis within the objective, would reduce the lactose deficit by 8.7% to 194,000 tonnes. Overall the results of this thesis indicate that including lactose yield in the selection objective has the potential to modify the composition of milk to make it more suitable for the production of WMP and increase the potential for profit in the industry.

Declarations

This thesis contains no material that has been accepted for a degree or diploma by the University or any other institution. To the best of my knowledge no material previously published or written by another person has been used, except where due acknowledgement has been made in text.

This thesis has been written with chapters formatted as papers for publication. Therefore there is some repetition of chapter introductions or methods, each chapter contains a full discussion, with the final general discussion chapter providing a succinct discussion of key findings of this thesis. Each chapter has been formatted for the New Zealand Journal of Agricultural Science and each has a complete list of references. The submitted manuscripts include supervisors as co-authors, however, for each chapter I planned the study, undertook the analysis and wrote the manuscripts with directions of those co-authors.

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“The presence of those seeking the truth is infinitely to be preferred to the presence of those who think they've found it.”

Sir Terry Pratchett, Monstrous Regiment

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P:P+L = Protein-to-protein-plus-lactose ratio
P:F = Protein-to-fat ratio
TMY = Total lactation milk yield
MY = Daily milk yield
TFY = Total lactation fat yield
FY = Daily fat yield
TPY = Total lactation protein yield
PY = Daily protein yield
TLY = Total lactation lactose yield
LY = Daily lactose yield
MS = Milk solids
MSY = Milk solids yield
FP = Fat percentage
PP = Protein percentage
LP = Lactose percentage
SCS = Somatic cell score calculated as Log_2(somatic cell count)
DIM = Days in milk
F = Holstein-Friesian
J = Jersey
OT = Other breeds (Ayrshire, Brown Swiss, Guernsey, Milking Shorthorn.)
FxJ = Holstein-FriesianxJersey crossbred cows
BW = Breeding Worth
EBV = Estimated breeding values
WMP = Whole milk powder
SMP = Skim milk powder
WP = Whey powder
BMP = Butter milk powder
MPC(90) = Milk protein concentrate (90% protein)
MPSM = Moorepark processing sector model
DM = Dry matter

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Appendix one