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GENETICS OF FEED INTAKE AND EFFICIENCY IN GRAZING DAIRY COWS

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Abstract

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Feed efficiency in dairy cows is widely acknowledged as a highly desirable characteristic to improve because of its well-documented impact on production costs. Traditional measures of feed efficiency have used ratio traits, specifically energy conversion efficiency, but these have undesirable statistical properties. Alternative measures of feed efficiency are those based on the residuals from regression-type statistical models, the most common of which is residual energy intake (**REI**). Residual energy intake is defined as the difference between actual and predicted intake and is usually derived from least squares regression models. The general objective of this thesis was to quantify phenotypic and genetic (co)variances between the feed intake complex, performance, and fertility traits in lactating Holstein-Friesian dairy cows. A total of 8,199 feed intake records from 2,693 lactations on 1,412 grazing lactating Holstein-Friesian dairy cows from experimental farms were used. Several alternative efficiency definitions were developed, each with their own respective strengths and weaknesses. Exploitable genetic variation was demonstrated to exist for the range of alternative efficiency traits, and the magnitude of this variation was sufficiently large to justify consideration of the feed efficiency complex in future dairy breeding goals. The heritability estimates for the different efficiency traits estimated using repeatability models varied from 0.06 to 0.21. Variance components, however, differed across lactation when estimated using random regression models; for example, the heritability of REI varied from 0.04 (34 DIM) to 0.11 (280 DIM) across lactation. Phenotypic

correlations among many traits including REI and energy balance (EB) differed not only by stage of lactation but also by cow parity. Moderate to strong genetic correlations existed between REI and EB across lactation (ranging from 0.45 to 0.90). Albeit associated with large standard errors, estimated genetic correlations between feed efficiency and reproductive performance were either neutral or favourable suggesting greater genetic merit for feed efficiency does not appear to be antagonistically genetically correlated with reproductive performance. Selection index calculations using the current economic weights in the Irish Economic Breeding Index, and genetic (co)variances estimated in this thesis, indicate that the inclusion of REI in the index with an economic weight of \notin 0.078/UFL will generate animals with improved REI.

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 the text.

This thesis has been written with chapters formatted as papers for publication. Therefore there is some repetition of chapter 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 Journal of Dairy Science and each chapter 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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Go raibh maith agaibh as bun mo chroí.

"One day, in retrospect, the years of struggle will strike you as the most beautiful"

Sigmund Freud

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AFC = Age at first calving BCS = Body condition score BW = Body-weight $BW^{0.75} = Metabolic body-weight$ CFS = Calving to first service interval CIV = Calving interval CV = Coefficient of variation DIM = Davs in milkDMI = Dry matter intake EB = Energy balanceECE = Energy conversion efficiency ECE_{adi} = Energy conversion efficiency adjusted ECE_{maint} = Energy conversion efficiency taking account of maintenance ECR = Energy conversion ratio EBI = Economic breeding index EBV = Estimated breeding values FC = Fat concentration FtW = Feed to body-weightICBF = Irish cattle breeding federation KG = KilogramKR = Kleiber ratio LC = Lactose concentration MEff = Metabolic efficiency MS = Milk solidsNEI = Net energy intake NEL = Net energy for lactation NEM = Net energy of maintenance NS = Number of servicesPEMEP = Partial efficiency of milk production PEMEP_{Nut} = Partial efficiency of milk production based on nutritional tables PC = Protein concentration PRFS = Pregnancy rate to first service PR42 = Pregnancy in first 42 days of breeding season PR84 = Pregnancy in first 84 days of breeding season REI = Residual energy intake REI_{maint} = Residual energy intake taking account of maintenance REP = Residual energy production REP_{maint} = Residual energy production taking account of maintenance RIEP = Residual intake and energy production SE = Standard errorSR21 = Submission rate in the first 21 days of the breeding season UFL = Unité fourragère du lait

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