Evaluation of different models to define a more suitable residual feed intake estimation in sheep

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Residual feed intake (RFI) is the difference between an animal's actual feed intake (FI) and its expected feed intake based on its size and growth or level of production. There is a lack of studies investigating the incidence of wool growth in the RFI estimation. This study aimed to compare different models for the estimation of RFI in Merino lambs, based on data of 577 animals, born in 2018 and 2019, sired by 16 rams. For both generations, after 14 days of acclimatization, the one-year-old lambs (296±48 days) were allotted to one of six RFI tests based on sex, birth type and age. In each test, animals were allocated to one of five outdoor pens with five automated feeding systems each pen in accordance with body weight (BW), sex and sire, during a 42-day test period. Lambs were fed *ad libitum* with Lucerne haylage (CP 22.0%, FDA 27.4%, FDN 35.1%, EE 2.2%). Models were compared using the Akaike Information Criterion (AIC). A first comparison considered the basic model including as fixed effects sex-pen-trial, average daily gain (ADG), mean metabolic weight (MW), and then we evaluated the inclusion of the following effects: birth type, lambing batch-year, age, rib-eye area, fat thickness, and two estimates of wool growth during the test, Trial Clean Fleece Growth and Trial Staple Length Growth, calculated using the Wool Production Potential principles. Another analysis was conducted using only 2019 progeny when Staple Length Growth (SLG) was recorded during the test. The model was as described above but, in this case, estimates of wool growth were SLG, estimated greasy fleece growth based on SLG and an ADG that did not consider the weight of the wool were included. The results indicated that the basic model (sex-pen-trial, ADG, MW) is the most parsimonious for both analyses, the others fixed effects, body composition and fleece growth traits were not significant (P>0.05) (AIC difference >2). Furthermore, RFI values estimated with the basic and alternative models were highly correlated (r=0.99). In conclusion, it might be not necessary to include estimations of wool growth during 42-day tests in RFI models when evaluating Merino sheep.

Multitrait analysis of RFI: heterogeneity of residual variances and modelling of body weight change

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In the usual definition of RFI dry matter intake (DMI) is regressed on energy sinks. This implicitly assumes that energy sink covariates are measured with little or no measurement error and a missing covariate for an animal results in deletion of its records for RFI. An alternative is to apply a multitrait (MT) model which can address these deficiencies. In this approach Cholesky decomposition is applied on MT variance covariance matrix (VCV) of energy sinks to derive MT RFI. Here DMI is expressed in a sequential relationship that is conditional on the different energy sinks (energy corrected milk (ECM), metabolic body weight (mBW), body weight loss (BW_{LOSS}), body weight gain (BW_{GAIN})). Because accuracy of production and intake measurements vary across lactation stages the heterogeneity of residual variances have not been reported for MT approach. Also, it is hypothesized that some issues in deriving RFI from production traits may be rooted in the difficulty to accurately model BW changes during lactation. The objective was to model BW change during lactation, as BW_{LOSS} and BW_{GAIN} traits and test effects of heterogeneity of residual variances on estimates of genetic parameters for RFI. Data was from 731 Nordic Red cows from four Finnish research farms including 20,533 weekly records. Traits were ECM, mBW, BW_{LOSS}, BW_{GAIN} and DMI. Lactation period was divided into five residual classes: <5, 5-8, 9-12, 13-32 and >33 lactation weeks. A MT repeatability animal model with age, lactation week, year-season, herd-test-month, random permanent environment, and animal effects was used to estimate MT VCV matrix. A square-root free modified Cholesky decomposition was then applied on VCV matrix to derive the MT RFI. During lactation, heritabilities for sink traits ranged from 0.15-0.25, 0.65-0.80, 0.04-0.11, 0.08-0.27 and 0.30-0.36 for ECM, mBW, BW_{LOSS} and BW_{GAIN} and DMI, respectively. Heritabilities for MT RFI were 0.06, 0.08, 0.09, 0.09, 0.07, for the five residual classes, respectively. Accounting for heterogeneity of residuals and modelling body weight change gave a reasonable description of RFI across lactation.