Hybrid local and global sensitivity analysis: Evaluation of dairy cow response predicted through INRA 2018 feeding system according to feed characteristics

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Two sensitivity analysis (SA) approaches were applied to the INRA 2018 feeding system to identifying the contribution of feed characteristics to the variation of the predicted animal responses. The SA has been performed in ruminant fields mainly by regression-based approaches that assume monotonicity of models. However, because INRA 2018 feeding system has complex models including interaction between feed characteristics, monotonicity cannot be secured. Thus, we applied not only differential-based local SA but also a variance-based global SA to evaluate our system. Five feed characteristics identified to affect animal responses prediction were chosen as input variables: organic matter digestibility (OMd), gross energy (GE), crude protein, and effective degradability and true digestibility of nitrogen. For the simulations, six reference diets for 2nd parity lactating cows at week 14 of lactation have been formulated. Overall, the relative sensitivities to input variables were consistent between both approaches. However, the sensitivity was different for dry matter intake (DMI) and milk protein yield (MPY) between diets. With grass hay-based diets, DMI appeared less sensible to marginal variations in inputs with local SA, but showed a large interaction among input variables in global SA, while MPY showed the opposite trend. Regardless of the diet, the interactions took in mainly OMd and GE, the input variables that have the greatest impact on the energy/protein ratio that regulates DMI and MPY in the model. This work showed the advantages of a hybrid approach with two SA methods for analyzing ruminant feeding systems.

Predictive modelling of dry matter intake in lactating dairy cows based on routinely available variables

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Predicting dry matter intake (DMI) is crucial for farm management. The study aimed to develop a model based on readily available variables on a dairy farm. The data set collected in barn, between November and March for respectively 2015 to 2021, included 6202 weekly averaged daily observations in 413 lactations from 273 Holstein cows. Data were analyzed using R Statistical Software (v4.1.2; R Core Team 2022). A correlation analysis was performed to identify the best predictive variables. We identified five animal-related and two diet-related variables as the most correlated to DMI. Afterwards, a model was developed using backward regression from a full model consisting 7 variables. After removing non-significant variables (days in gestation, metabolic body weight, and dietary net energy of lactation), the selected predictive variables (mean ± SD) were the following: parity 2.5 ± 1.6; Week of lactation (WOL) 14.9 ± 10.9; energy corrected milk (ECM) 33.7 ± 7.6 kg/d and neutral detergent fiber (NDF) 354 ± 59 g/kg DM). The metrics used for the evaluation were the root mean squared prediction error (RMSPE), its decomposition, and a concordance correlation coefficients (CCC) analysis was performed. The resulting prediction equation was DMI(kg/d) = 16.86 – (0.18 × Parity) + (0.24 × ECM(kg/d)) – (0.02 × NDF(g/kg DM))) + (0.29 × WOL) – (0.005 × WOL_2) (RMSPE = 1.45 kg, 7.16% and CCC = 0.90). Where parity is equal to 1 for multiparous and 0 for primiparous. In conclusion, our study successfully developed a predictive model for dry matter intake (DMI) in lactating dairy cows using easily accessible variables in dairy farms.