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Take home message When accurate high throughput monitoring and a steady environment are used, the variability of residual feed intake is only 8% of the variability of energy intake in Holstein cows over a full lactation. Even in these experimental conditions, only 59% out of these 8% are really associated with feed efficiency differences and not with errors.

Introduction Reducing the use of resources to maintain production and decrease dairy cow impact on the environment is a major challenge to tackle and is known as improving feed efficiency. Feed efficiency is often estimated with the residual intake defined as the difference between the actual feed intake and the feed intake predicted from the energy consumed or produced by the major biological functions (lactation, body reserves gain and loss and maintenance) (Berry and Crowley, 2013). As residuals of a statistical model, residual intake does not only include feed efficiency differences, but also the accumulated errors of model fitting and errors of measurement. Aggrey and Rekaya (2013) in broilers and Savietto *et al.,* (2014) in beef cattle used a mixed model with random animal effect to isolate the REI only associated with animal feed efficiency differences and not with errors. The objective of the present study was to estimate the part of residual intake variability in dairy cows really associated with feed efficiency differences and less with errors, thanks to a mixed model with random animal effect (Fischer *et al.,* 2017).

Material & methods Holstein cows were housed in a free-stall barn and fed with a single TMR based on corn silage and concentrates during the whole lactation. One hundred and nineteen cows were monitored throughout the first 238 days in milk for daily individual feed intake as the difference between offered dry matter and next morning refusals dry matter. All cows were also monitored for morning body weight after milking, daily milk yield, twice a week daily milk protein, fat and lactose, and monthly body condition score with a 0.25 increment scale going from 0 for an emaciated cow to 5 for a fat cow. Feed efficiency was estimated as the residual energy intake (REI): the residual of the linear regression of average net energy intake on average net energy in milk, average metabolic body weight and body condition score gain and loss, both multiplied by average body weight. To estimate the REI associated with feed efficiency and not with errors, the variables used to estimate REI - milk yield and composition, body condition score change, feed intake and body weight - were averaged per 2 week period to create repeated measures per cow during the 238 monitored days. A mixed model was then fitted with random cow-specific slopes for the variables and a random cow-specific intercept. The difference between the energy intake predicted with the cow-specific regression slopes and intercept and the energy intake predicted with the population average slopes and intercept was interpreted as animal variability in feed efficiency and not the error.

Results & discussion The variability of REI represented 8% of the variability of the actual net energy intake among the 119 Holstein cows over near the whole lactation. Of this 8% of REI variability, the cow-specific part isolated with the mixed model was only 59%. By definition, this 59% of REI variability is repeatable throughout time and associated with cows, and thus could be considered as feed efficiency differences. However, certain types of errors can be repeatable throughout time and associated with cows, such as sorting feed. The remaining 41% is by definition not repeatably specific to cows throughout time and therefore most probably associated with model fitting errors or measurement errors. However, when temporary events such as clinical mastitis, only affect intake or only affect a biological function, then it is cow-specific, but is not repeatable throughout time and will be included in the error of the mixed model and thus not considered as feed efficiency.

Conclusion When using high throughput monitoring of individual feed intake and of the major energy consuming functions in dairy cows fed with a single high energy diet during the whole lactation, residual energy intake differences among Holstein cows are only 8% of the total variability of feed intake. Thanks to a mixed model with cow-specific regression slopes and intercept, we were able to identify that of this 8%, only 59% may be associated with feed efficiency differences and not with model fitting errors or measurement errors.

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