Feed intake in merino ewes can be predicted using gas emissions

C Macleay[A], *and V Scanlan* [B]

[A]Department of Primary Industries, 3 Baron-Hay Court, South Perth, 6151
[B]Email: vicki.scanlan@outlook.com

Selecting sheep with reduced feed intake and increased feed efficiency drives profitability however feed intake is expensive and difficult to measure. Carbon dioxide and methane production are easier and cheaper to measure and have high phenotypic and genetic correlations with feed intake (Robinson, 2016; Paganoni *et al*., 2017). Therefore we hypothesised that feed intake can be predicted using gas emission data, generated from the Maternal Efficiency Project.

The Maternal Efficiency Project collected 2216 measurements of feed intake, CH_4 and CO_2 emissions between 2013 and 2016, from 1312 individual ewes born between 2011 and 2014. These animals had known pedigree, and were measured at 3 stages; post-weaning age (4-12 months), hogget age (12-24 months), and adult (24 months +). Gas emissions were measured using portable accumulation chambers, where individual sheep were held in an airtight chamber for 40 minutes, and gas concentrations measured every 10 minutes. Each sheep was measured twice, 2 weeks apart. Data was split into an 80% training set, to develop the model, and a 20% test set, to test the model. A linear mixed-effects model, using the *lme* function from the *nlme* package in RStudio (Pinheiro et al. 2013), was used to analyse the variables and identify those significant in explaining the variation in feed intake. The likelihood ratio test (Pinheiro & Bates, 2000), which compares the goodness of fit of two statistical models, assisted in determining which combination of variables produced the best model.

Feed intake is best predicted when using the variables liveweight (kg, weight), carbon dioxide output (%, co_2), methane output (mg/min, ch_4) and ewe age (stage: post-weaning, hogget or adult), with ID and sire set as random factors (repeat measures), where ID is nested within sire. Stage was specified as a variable with non-constant variance, corrected in the model using varIdent. The variables of growth and drop (year of birth) were significant however did not improve the fit of the model, and as a result were dropped. The final model is specified below.

```
Intake = 0.016weight + 0.229co2 -0.063stage + 0.003ch4 + 0.132,
       random=~1|sire/id, weights=varIdent(form=~1|stage)
```

Actual and predicted values for feed intake were highly correlated with an, R^2 value, of 0.8 (Figure 1.). Root mean square error of prediction (RMSEP) was used to test the model uncertainty in predictions. RMSEP results for the training dataset (0.185) and test dataset (0.202) suggests the model predicts relatively well against actual intake.

Our hypothesis that feed intake in merino ewes can be predicted using gas emissions is supported. Feed intake can be used as a tool for selecting productive animals however it must be used in combination with other production traits such as fleece weight and liveweight to avoid indirect selection for smaller or lower wool producing animals.

Feed intake and gas traits measured at a young age are highly correlated with adult measurements (Paganoni *et al*. 2017). Therefore, sheep can be measured for these traits when they are young, allowing desirable animals to be selected earlier, rather than waiting to measure them as adults. The ability to use gases to predict feed intake, as well as measuring them at a young age, makes feed intake measurements even cheaper, easier and quicker than current methods, and can be used by producers as a selection tool for breeding more profitable sheep that are also better for the environment.

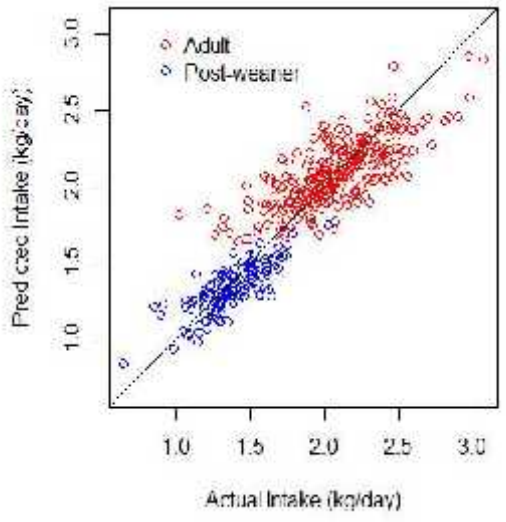

Figure 1. Predicted feed intake plotted against actual intake, R^2 of 0.8.

References

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The data for this analysis was provided by the Maternal Efficiency Project, a collaboration between Murdoch University and Department of Primary Industries and Regional Development.