New Zealand Greenhouse Gas Inventory
Approval for change to emission factor, parameter or methodology

Reviewer	
Date of review	

Inventory sector[1]	Agriculture
Name of EF, variable or category	Nu (partition of excreta N into urine)
Current value of emission factor, variable or methodology Tier	((10.5 × Nd) + 34.4) × Nex/100) Where Nd is dietary N and Nex is the total amount of excreta N.
Suggested value of emission factor, variable or methodology Tier	
Use from year (start year)	
Recommend that a change to the new value or methodology is approved	

Please comment on whether the supporting review or report sufficiently covers the following topics and provides adequate justification for a change.

	Yes/no	**Comment**
Is the need for a change well documented?	Yes	The recommendations are based on a well-referenced and comprehensive data set.
Is the proposed change scientifically defensible?	Yes	The statistical methods are appropriate for estimating predictive performance of the recommended equations.
Has any documentation been peer-reviewed or published?	Yes	The data set used is derived from peer-reviewed articles.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	The recommended equations can effectively replace that presently used in the current Agricultural Inventory Model.
Is any new EF, variable or methodology comparable with any other countries?	Yes	The report compares equations with those published in other countries.
Is the level of uncertainty reported?	Yes	The prediction errors for the recommended equations are reported and shown to be lower than that presently used.
Is there a comparison with IPCC default emission factors, variables or Tier 1 methodology?	Yes	Using the recommended equations in the Agricultural Inventory Model show changes in NO_2 within the margin of error of the inventory.

[1] Energy, Industrial Processes, Solvents, Agriculture, LUCF, Waste

Report on
Pacheco,D., Waghorn,G. and Rollo,M. (2018)
"Methodology for splitting nitrogen between livestock dung and urine."

This report proposes changes to the equation used in the Agricultural Inventory Model (AIM) for estimating urinary and faecal nitrogen excretion from ruminant livestock, from which nitrous oxide emissions to the atmosphere are calculated.

The equation currently used in AIM is that of Luo and Kelliher (2010) which predicts the percentage of urine N in total excreta N. A subsequent model - Thomson and Muir (2016) – was developed which predicts the amount of urine N excreted. The authors of the present report make a convincing case for predicting the amount of faecal N excreted, because it is less prone to measurement error than urinary N during N balance studies.

A comprehensive data set has been compiled comprising of 448 mean nitrogen balances from ruminants (dairy cattle, beef cattle, sheep and deer) fed forage-based diets. This is considerably larger than the 33 and 72 values reported in the 2010 and 2016 predictions.

The data set was used to derive predictive equations for estimating the partition of excreta nitrogen between urine and faeces. The accuracy and precision of the predictions were assessed by a number of statistical parameters, which enabled comparisons of mean bias, slope bias and random error to be made. Although statistics is not my area of expertise, the parameters used are consistent with those reported for other published predictive models. A feature of the approach taken here is to use 80% of the data set for model development and to compare predictions with actual data from the remaining 20% of data.

A comparison of the existing models indicates the Luo and Kelliher (2010) model has a large mean bias and only moderate accuracy for sheep and dairy cattle, while Thomson and Muir (2016) overestimated the urinary N excretion of dairy cattle, had a large slope bias for beef cattle and a large mean bias for sheep.

After evaluating a number of models based on the expanded data set, several are recommended depending on the scenario deemed most appropriate for the AIM. These include:

- A replacement of the current equation with one estimating the percentage of urine N in total excreta N across all classes of livestock.
- Different equations estimating the percentage of urine N in total excreta N for each livestock class separately.
- Two equations for estimating total faecal N excretion – one for dairy cattle, beef cattle and deer and a separate one for sheep.

In comparison with overseas models using the same input variables, the predicted values had lower bias and were more accurate. This is likely due, in part, to the diets used in overseas studies being based on total mixed rations rather than forages.

The equations estimating faecal nitrogen output seem the most appropriate, as they are based on data from nitrogen balance trials that have lower measurement errors and use variables that are

already included in the AIM (Nitrogen intake, concentration of N in the dietary dry matter and dry matter intake).

Replacing the current equation with any of those recommended in this report resulted in a change in estimated nitrous oxide production of less than 2%. However, the main issue with estimating nitrous oxide production in the AIM is not concerned with the partition of nitrogen excreted between faeces and urine, but rather in the estimation of total nitrogen excretion itself.

The AIM model calculates total nitrogen excretion as the difference between nitrogen intake and the sum of nitrogen retained in body tissues, milk, wool and/or velvet. These parameters are all subject to a great number of variables which are not reflected in the model inputs. Indeed, in the absence of more detailed information, default values are used for nitrogen concentrations in the diet and animal tissues, as well as for animal performance to estimate dry matter intakes. These are therefore more likely to produce greater error in estimated nitrous oxide production, than any from the equations for partitioning excreta nitrogen.

I congratulate the authors on a well-presented report and support their conclusions. The AIM should be updated to incorporate the most appropriate recommended equations – preferably those estimating faecal nitrogen output. More detailed estimates of AIM input variables should be used as they become available.

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