Ministry for Primary Industries
Manatū Ahu Matua

MPI Policy and Trade
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Minor improvements and corrections proposed for inventory model

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Main Purpose: ☑ Decide ☑ Discuss ☑ Note

Purpose of this paper

1. To seek a recommendation from the Panel on the following minor improvements and corrections planned for next year's inventory submission including:

   - Re-specifying the equation used to estimate energy efficiency for maintenance (k_m), for beef cattle and sheep;

   - Making a slight alteration to the k_m equation for deer; and

   - Using the IPCC default value for the gross energy content of feed - 18.45 MJ/kg Dry Matter (the value currently used is 18.4 for cattle and deer, 18.5 for sheep).

   These improvements aim to improve the accuracy of emissions reporting. The changes will also improve alignment and consistency with the Overseer model.

2. Attached to this paper is an extract from a soon to be finalised report; *Recommendations for updating the methodology used to calculate metabolisable energy (ME) requirements of dairy, beef and sheep in OVERSEER and the Agricultural Inventory Model (AIM).* This report contains recommendations for improving the animal metabolisable energy (ME) intake requirement equations in Overseer and the inventory model, and is referred to in this briefing as the *recommendations* document.

First proposed change – Efficiency of energy use for maintenance and milk production (km)

3. This change will modify the equation used to estimate the efficiency of energy used for maintenance and milk production. Equation 1 is used in the inventory model to help estimate energy requirements for sheep and beef cattle, which is then used to estimate dry matter intake and emissions.

4.   In the current inventory model the amount of metabolisable energy required for cattle, sheep and deer is calculated using the guidelines developed by CSIRO (1990).

5.   Equation 1 is used to calculate k_m, which is the efficiency of energy use for maintenance for beef cattle and sheep. The *recommendations* document suggested that equation 2 be used to calculate K_m instead.

Equation 1. Energy efficiency for maintenance (k_m) - Current equation used for sheep, and beef cattle

$$k_m = 0.02 \times Feed_{ME} + 0.5$$

Where:
- k_m = Efficiency of energy use for maintenance or milk production
- $Feed_{ME}$ = metabolisable energy content of feed (MJ/kg DM).

Equation 2. Energy efficiency for maintenance (km) - Proposed equation

$$k_m = 0.35 \times q_M + 0.503$$

Where:

- q_m: energy density of pasture: q_m = $Feed_{ME}$/GE. q_m represents the ratio of pasture ME concentration to the gross energy concentration of feed.
- GE = gross energy content of feed (recommended value of 18.45 MJ/kg DM)

6.   Equations 1 and 2 are mathematically equivalent, as 0.35/18.40 is approximately equivalent to 0.02. In making this change, the only difference in emissions estimates will be due to the differences in rounding of these equations. In equation 1, the 0.02 value already factors in a GE value of 18.4 MJ/kg DM.

7.   Both of these equations are outlined in the CSIRO (1990) guidelines, which also mentions that equation 2 could be written as equation 1 when the gross energy content of feed was equal to 18.4.

8.   For dairy cattle, equation 2 is already used to estimate k_m, so no change is needed.

Second proposed change - slight alteration to the km equation for deer

9.   A small change to the K_m equation for deer is recommended in this paper. k_m for deer is currently calculated using the same form as equation 2, but with different coefficients:

- k_m = 0.2q_m + 0.5

10. The current deer metabolisable energy equations are based on the recommendations by Bown et al (2012)[1], and were recommended for inclusion in the inventory by the Panel in the same year.

11. To be consistent with the suggestions in the first proposed change, it is recommended that the 0.5 term be changed to 0.503. After this change, the k_m equation for deer would be:

- $k_m = 0.2q_m + 0.503$.

Third proposed change – Use of default IPCC value for the gross energy of feeds (18.45 MJ/kg DM)

12. This suggested change was also included in the *recommendations* document. As previously mentioned, the inventory currently uses a GE value of 18.4 MJ/kg DM, for all tier 2 animal species (Dairy and beef cattle and deer). Sheep use a value of 18.5.

13. The movement to the GE value of 18.45 is recommended because it is consistent with the 2006 IPCC guidelines (page 10.21, volume 4). As a related benefit, the change will improve the alignment between the inventory methodology and the Overseer model.

Effect of corrections on inventory

14. The implementation of these changes has a small impact on emissions estimates. After the correction is applied, estimated total agricultural emissions are around 0.2% (96 kt CO_2-e) higher, compared to emissions estimates in the current AIM (see table below). The effect of this correction is consistent across the 1990 to 2017 time series.

Table 1: Comparison of current and previous emissions estimates before and after ME equation correction, 1990 to 2017

Emissions (kt CO2-e)		1990	2017	Change in emission outputs between 1990 and 2017 (kt CO_2-e)	Percentage change in emission outputs between 1990 and 2017
Total emissions from Agriculture (kt CO_2-e)	2019 (1990-2017) emissions estimate *without* correction	34,257	38,881	4,623	13.5%
	2019 (1990-2017) emissions estimate *with* correction	34,354	38,976	4,623	13.5%
	Difference in emission estimates compared to current inventory	96	96	-1	
	Percentage difference in emission estimates	0.28%	0.25%		

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[1] Evaluation of the energy equations used by the National Enteric Methane Inventory", Bown, M.D., Thomson, B.C., Cruickshank G.J. and Muir P.D

Strategic opportunities

15.   The implementation of these corrections and improvements will lead to a more accurate inventory that is more consistent with the Overseer model.

Next steps

16.   The correction and improvements discussed here will be implemented in the 2020 version of the inventory.

Recommendations

It is recommended that the Agricultural Inventory Advisory Panel:

17.   ***Recommend*** the modification to the equation used to estimate energy efficiency for maintenance be implemented for the 2020 inventory submission:

18.   ***Recommend*** the value for gross energy be modified to 18.45 MJ/kg DM for the 2020 inventory submission:

Agree / not agreed

Approved/ Not Approved/ Approved as Amended

Gerald Rys
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Date

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