MPI Policy and Trade
Agricultural Inventory Advisory Panel Meeting
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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 provide information on the following minor improvements and corrections planned for next year's inventory submission:

   - Corrections to the calculation of metabolisible energy (ME) requirements.

   - Improving the Agriculture Inventory Model (AIM) so that it operates on a 'daily time step' rather than a 'monthly time step'.

2. Attached to this paper are the reports:

   - Wheeler, D, 2018 (unpublished) *Proposed changes to the animal metabolisable energy requirements model in Overseer[1]*.

Proposed correction – metabolisible energy required for gestation

3. The correction discussed here will change the metabolisible energy equation in the Inventory so that the ME term for gestation is moved outside of the production term.

Background – Reporting of corrections

4. Under the United Nations Framework Convention on Climate Change (UNFCCC) reporting guidelines on annual greenhouse gas inventories, countries are required to report any changes in emissions estimates due to the correction of errors[2]. This reporting involves:

   - An explanation of the error, and;

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[1] Only section 3.1 is relevant for this briefing
[2] http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf#page=2 paragraph 45

- The impact of the error (and its subsequent correction) on emissions estimates, for all reporting years in the time series.

Current calculation of metabolisible energy in AIM

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

Equation 1. Total metabolisable energy requirements

$$ME_{total} = ME_m + 1.1 \times ME_p + ME_{graze}$$

Where:
- ME_{total} = Total ME requirements of animal (MJ/d)

- ME_m = metabolisable energy required to maintain animal weight (MJ/d).

- ME_p = metabolisable energy required for production (MJ/d)

- ME_{graze} = additional metabolisable energy expenditure of grazing (MJ/d).

6.   The ME_p term can be broken up into separate terms which calculate the amount of energy required for things like milk production and live weight gain (equation 2).

7.   Although the ME_m and ME_p terms are set out separately, there is some interaction between these two variables, as a higher level of production will also increase the amount of energy required for maintenance activities (such as respiration or cardiac output). To account for this the term ME_p in equation 1 is multiplied by 1.1 (CSIRO, 1990[3]).

Equation 2. Metabolisable energy requirements for production

$$ME_p = ME_l + ME_c + ME_g + ME_{other}$$

Where:
- ME_l: ME required for milk production (MJ/d)
- ME_c: ME required for gestation or growth of the conceptus (MJ/d)
- ME_g: ME required for live weight gain (growth) (MJ/d)
- ME_{other} = ME required for growth of wool or velvet (MJ/d)

8.   Of particular note in these equations is that the term for gestation (ME_g) is included in the production term (which is multiplied by 1.1 in equation 1). This has been identified as an error (the ME_g term should not be included in the production term)

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[3] CSIRO. 1990. Ruminants: Feeding Standards for Australian Livestock. Victoria, Australia: Commonwealth Scientific and Industrial Research Organisation.

following recent work comparing the inventory with the Overseer model. Further investigation into the CSIRO (1990) guidelines have also confirmed this.

Comparing the Overseer model with the national inventory

9.   OVERSEER® Nutrient Budgets (Overseer) is a farm level modelling tool originally developed to estimate farm level nutrient budgets. Overseer also has a module for estimating greenhouse gas (GHG) emissions.

10.   The GHG component of Overseer was compared with the AIM. The objective of this work has been to understand how well Overseer is aligned with the national inventory methodology, and determine the changes needed to ensure that Overseer can provide an accurate assessment of GHG emissions. This work has included a comparison of the metabolisable energy (ME) requirements components of both models.

11.   A workshop was held with a group of experts in March 2018 to compare the ME components of both models. The findings of this workshop were written up in a report by Wheeler (2018), which contained recommendations for changes to the ME component of Overseer.

12.   During this work it was found that inventory model incorrectly includes the ME_g (pregnancy) term within the ME_p (production) calculations, for all four main animal categories. A search within the AIM code has confirmed this. This error had been present in the model since at least 2005.

Proposed correction

13.   It is proposed that the metabolisable energy equations in the national inventory be corrected so the ME_g is outside of the production term.

Equation 3. Corrected metabolisable energy requirements equation

$$ME_{total} = ME_m + 1.1 \times ME_p + ME_{graze} + ME_g$$

Where:
- ME_{total} = Total ME requirements of animal (MJ/d)
- ME_m = metabolisable energy required to maintain animal weight (MJ/d).
- ME_p = metabolisable energy required for production (excluding MEg) (MJ/d)
- ME_{graze} = additional metabolisable energy expenditure of grazing (MJ/d).
- ME_g: ME required for live weight gain (growth) (MJ/d)

Effect of correction on inventory

14.   The correction of this error has a small impact on emissions estimates. After the correction is applied, estimated total agricultural emissions are around 0.3% (120kt CO2-e) lower, compared to emissions estimates in the uncorrected AIM (see table

below). The effect of this correction is consistent across the 1990 to 2016 time series.

Table 1: Comparison of current and previous emissions estimates before and after ME equation correction, 1990 to 2016

Emissions (kt CO2-e)		1990	2016	Change in emission outputs between 1990 and 2015 (kt CO_2-e)	Percentage change in emission outputs between 1990 and 2016
Total emissions from Agriculture (kt CO_2-e)	2018 (1990-2016) emissions estimate *without* correction	34,581	38,727	4,145	12.0%
	2018 (1990-2016) emissions estimate *with* correction	34,461	38,603	4,141	12.0%
	Difference in emission estimates compared to current inventory	-120	-124	852.0	
	Percentage difference in emission estimates	-0.35%	-0.32%		

Proposed improvement – moving to a daily time step

15. The current tier 2 portion of the agriculture inventory model calculates energy requirements, intake and emissions using monthly time intervals. This allows for the inventory to account for changes in
    - animal populations,
    - production levels,
    - births and deaths

    that occur over the course of a year. However, the model cannot incorporate birth and slaughter dates that occur mid-month (i.e. not at the beginning or end of a month) in a 'non-clumsy' way.

16. AgResearch have modified the inventory model so that it also has the ability to calculate emissions using a daily time step. This improvement has an insignificant effect on estimated emissions, but will have the following advantages:

    - Ability to incorporate birth and slaughter dates that occur mid-month more sensibly
    - Improved transparency
    - More easily able to account for long-term trends in slaughter and birth dates that may have occurred since 1990.

Strategic opportunities

17.   The implementation of these corrections and improvements will lead to a more accurate and transparent inventory, and an improved understanding of emissions drivers and trends. The inventory will also be able capture improvements in emissions intensity more easily.

Next steps

18.   The correction and improvement discussed here will be implemented in the 2019 version of the inventory.

Recommendations

It is recommended that the Agricultural Inventory Advisory Panel:

19.   *Note* the correction to the metabolisable energy equations planned for the 2019 inventory submission:

20.   *Note* the intention to improve the Agriculture Inventory Model by making calculations at daily, rather than monthly time intervals

Agree / not agreed

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Approved/ Not Approved/ Approved as Amended

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Date

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