Ministry of Agriculture and Forestry

Te Manatu Ahuwhenua, Ngaherehere

REDUCING UNCERTAINTY OF THE ENTERIC METHANE EMISSIONS INVENTORY

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Main Purpose: ☑ Decide ☑ Discuss ☐ Note

Purpose of Report

1. The purpose of this paper is to summarise the report contracted by MAF from AgResearch on reducing the uncertainty of the enteric methane emissions inventory

2. Attached to this paper is the report, the reviewer's comments and the methodology change form required by MfE.

Summary

3. The current uncertainty of the national enteric methane (CH_4) emission inventory, expressed as a 95% confidence interval is ± 53%. This is based on methane yield measurements and estimates undertaken in New Zealand between 1996 and 2002. Since then a large amount of studies have been carried out and therefore a much larger pool of data is available to determine the uncertainty of the methane inventory.

4. Analyses were carried out for three animal classes; namely sheep < one year old, sheep > one year old and cattle. Extreme outliers were removed from the analyses since these were generally acknowledged as outside the physical limits for enteric methane emissions.

5. Two main methods are used in measuring CH_4 emissions. These are an indoor calorimeter and the SF_6 tracer technique which can be carried out indoors and outdoors. Indoor experiments generally have cut and carried feed and therefore feed dry matter intake (DMI) can be measured accurately from daily weighing of feed offered and feed refusal. In outdoor experiments DMI has to be estimated by a range of methods e.g. faecal collection and back-energy calculations.

6. For sheep less than one year old the two indoor measurement methods of calorimeter and SF_6 were virtually indistinguishable with means of 24.0 and 23.9 g CH_4 kg^{-1} DMI

respectively. Although means were indistinguishable, the SF_6 method was twice as variable as the calorimeter method.

7. For sheep more than one year old the two indoor measurement methods of calorimeter and SF_6 were virtually indistinguishable with means of 22.2 and 23.7 g CH_4 kg^{-1} DMI respectively. Although means were indistinguishable, the SF_6 method was twice as variable as the calorimeter method.

8. For sheep, both less than and more than one year old, it was concluded that the calorimeter method represented the "true" variation amongst animals as the variation in the SF_6 method also included the variation in the actual method it self, as well as the animals.

9. The statement of no significant difference between indoors and outdoors experiments appears to conflict with a statement in the appendices (pages 5 and 22 of the report). The authors have resolved the issue and it has been concluded that there is a difference between methane yields between grazing sheep and indoor sheep, for either age group, and it is highly significant, contrary to the statement on p5 of the report. The difference may stem from biases in estimating DMI for grazing sheep. In contrast, the difference between methane yields for juvenile (<1 year old) and mature (>1 year old) sheep is not significant, even though for grazing animals that difference is quite large.

10. It has been noted by the authors that due to this confusion it may mean that the reappraised uncertainty in the enteric inventory in section 4 of the report (p9) may need to have the different animal classes appraised separately (i.e., the CV of 3% may not be defensible for the methane yield of the "sheep <1 yr old" category). However, any such reappraisal is likely to be minor, and could await the greater rigour of a peer-reviewed article. Therefore, it is suggested that the coefficient of variation (CV) associated with the CH_4 yield of sheep of all ages be reduced to 3%.

11. For sheep less than and more than one year old, indoors and outdoors, the two methods had mean CH_4 yields that were statistically indistinguishable. Currently different CH_4 yields are used for the two different ages of sheep. It was therefore suggested that this be investigated further.

12. At the time of the AgResearch report, there were no data available from studies done on cattle in calorimeter chambers. For cattle indoors and outdoors, the mean CH_4 yields were virtually identical at 21.7 g CH_4 KG^{-1} DMI, with the CV for the SF_6 method being twice as high for indoors compared to outdoors

13. Suggested CV of 3% taking into account the result from sheep with SF_6 CV being half that of the calorimeter CV

Proposed changes to inventory

14. To assess uncertainty of the enteric CH_4 emissions inventory, the CV for CH_4 yield should be changed to 3%; this was the mean CV for sheep and cattle. Based on this statistical analysis this gives a 95% certainty that the inventory's true value is $\pm$ 16%.

Proposed changes to initial report and justification

15. The two recommendations of:

    a. for sheep divided by age into two classes, less than and more than one year old, the mean CH_4 yields were statistically indistinguishable

    b. The mean CH_4 yields of sheep and cattle were statistically indistinguishable

    There will be no change to the current CH_4 yields for either sheep or cattle until further research has confirmed this.

16. If the regionalisation of dairy is implemented into the inventory, the change in CV will only be applied to Sheep and Beef. Further work is required on the uncertainty of dairy when calculated at a regional level in order to take into account the increase in uncertainty around the population numbers. This is due to the smaller sample sizes.

Response to reviewer comments

17. The reviewer was generally happy with the outcome of the report with the main comments referring to a change in terminology and correction of typos and formatting. These will be passed onto the authors.

Strategic Risks

18. The original uncertainty was based on all available animal types and diets. This uncertainty is only based on one diet, pasture. Although 97% of New Zealand's livestock are pasture grazed, UNFCCC may not agree with this assumption.

Strategic Opportunities

19. Meeting New Zealand's UNFCCC obligations by improving the accuracy of the value of the Inventory.

Recommendations

It is recommended that the Agricultural Inventory Panel:

20.   **Agree** that the uncertainty of enteric methane emissions be reduced to a CV of 3% for the CH$_4$ yield for Sheep and cattle .

Agree/not Agree

21.   **Agree** that based on this change in the uncertainty of the methane yield, the overall uncertainty of the enteric methane emissions inventory, expressed as a 95% confidence interval, would be $\pm$ 16%

Agree/not Agree

22.   **Note** that the uncertainty analysis on the methane yield was determined using statistical methods only and doesn't account for a potential bias in methane emission yield for sheep < 1 year old that was noted in the report

Agree/not Agree

Andrea Pickering
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Approved/ Not Approved/ Approved as Amended

Alice Marfell-Jones
Manager Monitoring and Evaluation
Chair Agricultural Inventory Panel

Date