



NITROUS OXIDE AND METHANE EMISSIONS FROM SWINE

Authors: Andrea Pickering

Main Purpose: ☒ Decide ☒ Discuss ☐ Note

Purpose of Report

1. Seek approval from the Agricultural Inventory Advisory Panel on the recommendations to adjust emission factors and parameters for the estimation of emissions from swine, as detailed in this briefing.
2. Attached to this paper are the reports:
 - a. The report “*Recalculate Pork Industry Emissions Inventory*”
 - b. The review of the above report by Feedlot Services Australia (FSA).

Summary

Background

3. New Zealand has an obligation under United Nations Framework Convention on Climate Change Convention (UNFCCC) to report anthropogenic greenhouse gas emissions and removals every year. Emissions are reported in the annual submission of the National Inventory Report submitted to the UNFCCC. New Zealand also has a responsibility under the Kyoto Protocol to reduce emissions growth and if not successful will incur a financial cost.
4. The National Inventory Report (NIR) forms the basis of any financial cost that the country may have under the Kyoto Protocol. Therefore reported emissions and removals need to be as accurate as possible. New Zealand has a long standing research program in estimating country specific emission factors to aid in the improvement of reported emissions and removals from the land based sectors.
5. Changes beyond the default methodology and emission factors to take account of country specific factors are encouraged and need to be well documented and transparent.
6. As a matter of course the 2006 IPCC guidelines are not currently used in the estimation of emissions from the national greenhouse gas inventory (including agriculture). Until these guidelines are fully adopted countries must continue to use

the Revised 1996 IPCC Guidelines and IPCC good practice guidance unless a country can fully justify why they have changed. If a methodology, emission factor or parameter is not available from the current guidelines but is from the 2006 IPCC guidelines, a country is able to use the information contained in the 2006 IPCC guidelines when estimating emissions. Also, if a country has investigated an area and found the values in the 2006 IPCC guidelines are more appropriate then this too is a justification for changing.

Current Inventory

7. The NIR currently uses IPCC default emission factors for the Oceania region and proportions of manure to each management system to estimate emissions from swine. It also uses a Tier 1 methodology using a total swine population number rather than splitting swine numbers into different age and sex subcategory classes.
8. The Revised 1996 IPCC Guidelines default emission factors for swine are based on weight class population statistics for West Germany in the 1980's and do not account for New Zealand specific management practices.
9. Swine emissions only make up a small percentage of New Zealand's total agricultural emissions (0.6 percent in 2009) so are not a key category when assessed on an annual basis. However, a literature review on emissions from swine identified some areas where improvements could be made to improve the accuracy of emission estimates from New Zealand's national swine population.

Report

10. The report investigated the break down of the swine population into different age and sex sub categories in line with the Revised 1996 IPCC Guidelines, and 2006 IPCC Guidelines. The guidelines recommend dividing populations into subcategories where detailed data is available. This breakdown is then used in the development of the average emission factor values.
11. Authors obtained data from on farm surveying, the New Zealand Pork Industry Board, consultation with industry experts, and literature to develop New Zealand recommended values for all aspects in estimating emissions from swine.
12. Values were developed for each age and sex subcategory of swine as well as an mean value for swine in general.
13. Surveys covered various production types on 56 farms ranging in size from 130 to 3300 sows. In total, 67 percent of New Zealand's pork production was covered.
14. Survey forms and results for each site are appended in the report.

Recommendations from the report

Enteric fermentation

15. The Revised 1996 IPCC Guidelines default value for all countries and currently used for New Zealand is 1.50 kg CH₄/head/yr. The report recommends using a New Zealand-specific factor of 1.08 CH₄/head/yr based on the lower gross energy (GE) value of feed fed to swine in New Zealand, and the population subcategory breakdown. Other notable pork producing countries such as Spain, Denmark, Germany and Canada reported 0.95, 1.01, 1.17 and 1.50 respectively for 2009.
16. The proposed value is recommended for all years due to the expert opinion that the type of feed (and therefore GE of the feed) has not changed since 1990.

Methane from manure management

17. The IPCC default value for Oceania currently used is 20.00 kg CH₄/head/yr. The recommended value of 5.94 kg CH₄/head/yr is based on New Zealand information and is derived using the methodology outlined in the Revised 1996 IPCC Guidelines. Spain, Denmark, Germany and Canada reported 9.47, 2.07, 4.63 and 5.00 respectively for 2009.
18. Unfortunately, the Revised 1996 IPCC Guidelines derived value (5.94 kg CH₄/head/yr) was not assessed by the reviewer. Instead the value based on the 2006 IPCC guidelines (5.48 kg CH₄/head/year) was. However, the reviewer comments are also applicable to the Revised 1996 IPCC Guidelines derived value.
19. The lower value recommended for methane from manure management from the default of 20.00 kg CH₄/head/yr is mainly due to the reduction of the proportion of manure which is allocated to the anaerobic lagoon management system. The Revised 1996 IPCC Guidelines default EF used for NZ assumes 55 percent of manure in this system, while New Zealand surveys indicated this was more like 18 percent.

Nitrogen excretion rates

20. The IPCC default value (for Oceania) is currently 16.00 kg nitrogen (N)/head/yr. It is recommended that a Tier 1 value be derived using the methodology outlined in the 2006 IPCC guidelines. This methodology would use the swine population distribution as detailed in Appendix 5 of the report, swine population numbers from Statistics NZ, mean pig weight from by the New Zealand Pork Industry Board, and the annual N excretion rates.
21. The report did not investigate a Tier 2 methodology to determine N excretion from swine. The Revised 1996 IPCC Guidelines do not provide a methodology to derive a Tier 1 value, although they state that the N excretion rate “Estimates for cattle and swine may be too high. Hence, these estimates (default values) need further attention”.
22. The Tier 1 methodology outlined in the 2006 IPCC guidelines is $N_{\text{ex}} = N \text{ rate} \times \text{TAM}^1/1000 \times 365$. Using a weighted average of population distribution the report recommended a value of 10.80 kg N/head/yr. Notable pork producing countries

¹ Typical Animal Mass.

reporting Nex values are Spain 9.42, Denmark 8.40, Germany 11.13 and Canada 12.14. However, the report did not investigate applying the new methodology to data back to 1990. Average pig weight is reported by New Zealand Pork Industry Board back to 1990. This information along with other data detailed in paragraph 20 can be used to derive a time series of N excretion rates for swine.

Direct nitrous oxide emissions from manure management

23. The Revised 1996 IPCC Guidelines default methodology currently used separates manure into six manure management systems and provides default emission factors and proportions to estimate N₂O from manure management. The systems currently used for swine are detailed in the table below.

	Emission factor	Percentage of swine manure allocated to management system
Anaerobic Lagoons	0.001	55
Daily spread	0.000	0
Direct to pasture (reported elsewhere in animal production)	0.01 (NZ specific)	0
Solid Storage and Dry lot	0.020	17
Other	0.005	28

24. There are two options for consideration that could be implemented to improve nitrous oxide emission estimates from manure management:

Option 1: Based on a survey of the pork industry, the report found that the manure management systems reported in the 2006 IPCC guidelines describe the systems used in NZ more accurately. Therefore the 2006 IPCC default emission factors could be implemented in conjunction with country specific proportions of manure to each system.

However, due to implications for estimates of nitrous oxide from manure management of other species (poultry and dairy cattle), a second option may be considered, being;

Option 2: Continue to use the current manure management systems but use with country specific proportions of manure to each system.

25. Currently five percent of dairy manure is allocated to anaerobic lagoons and 97 percent of chicken manure to “other”. No work for dairy has been carried out on allocating manure management systems based on the 2006 IPCC guidelines. A recent poultry report (also presented to the panel in 2011) noted that further clarification on how poultry manure was managed in the different systems is required.
26. *Option 1:* the recommended values from the 2006 IPCC guidelines are detailed in the table below.

	Emission factor	Percentage of swine manure allocated to management system
a. Anaerobic Lagoons	0.000	20.5
b. Daily spread	0.000	25.7
c. Direct to pasture (reported elsewhere in animal production)	0.01 (NZ specific)	8.9
d. Pit storage	0.002	13.1
e. Composting (passive windrow)	0.010	3.0
f. Deep litter (no mixing)	0.010	0.7
g. Deep litter (no mixing) + composting	0.020	19.0
h. Deep litter (mixing) + composting	0.080	6.7
i. Anaerobic Digester	0.000	2.4

Five percent of dairy manure would continue to be allocated to anaerobic lagoons but the EF for anaerobic lagoons would change from 0.001 to 0.000 as recommended in the IPCC 2006 guidelines due to the lack of oxygen in the system. The proportion of poultry manure not directly applied to pasture range and paddock would continue to be allocated to an “other” category with the IPCC 1996 guidelines “other” EF.

27. *Option 2:* If the current manure management systems continued to be used the proportion of manure allocated to systems detailed in the table in paragraph 26 (systems d. to h.) would be grouped together under solid system and dry lot (42.5 percent of manure) and anaerobic digester grouped under “other” (2.4 percent). Anaerobic lagoons, daily spread and pasture range and paddock country specific values would be used (20.5, 25.7 and 8.9 respectively). The Revised 1996 IPCC Guidelines default EF’s as detailed in the table in paragraph 23 would be used.

Effect of changes

28. In comparison to the inventory submitted in 2011, the proposed changes have the following effect on the 2009 emissions estimates from swine. The table below outlines these individual changes and the cumulative total effect.

Change	Current value	Recommended value	Change to 2009 emissions estimate
Reducing the enteric fermentation value	1.50 CH ₄ /head/year	1.06 kg CH ₄ /head/year	- 2.98 Gg CO ₂ -e (1.6 percent).
Reducing the value for methane from manure management	20.00	5.98 kg CH ₄ /head/year	- 95.3 Gg CO ₂ -e (50.5 percent)
Reducing the N excretion rate	16.0	10.8 kg N/head/yr	- 14.0 Gg CO ₂ -e (7.4 percent)
Changing the proportion of N in each manure management system	Refer paragraph 23	Refer paragraph 26	+ 9.0 Gg CO ₂ -e (4.8 percent).
Total			105.8 Gg CO₂-e (56.0 percent)

Response to reviewer comments

29. The reviewer agreed with the report recommendations. However, as noted in paragraph 6, until the 2006 guidelines are fully adopted countries must continue to use the Revised 1996 IPCC Guidelines and IPCC good practice guidance unless a country can fully justify why they have changed. Therefore, the following recommendations will **not** be included at this time due to the lack of justification:

- Indirect nitrous oxide emission from manure management
- Direct nitrous oxide emissions from agricultural soils
- Indirect nitrous oxide emission from agricultural soils (volatilisation and leaching and runoff)

Details of these recommendations can be found in the report *Recalculate Pork Industry Emissions Inventory*.

Strategic Risks

30. The changes may not be accepted by the *United Nations Framework Convention on Climate Change* (UNFCCC) reviewers. However, if this is the case there is an extensive process which is followed in which New Zealand can state its case or change back to the IPCC default before any penalty would be applied.

Strategic Opportunities

31. New Zealand will be meeting the UNFCCC obligations of continual improvement of the National inventory

32. Although the new values will not make any noticeable difference to the total emissions estimate for New Zealand, the values used will now be well documented, therefore meeting the UNFCCC requirement for transparency.
33. Preparing to meet updated reporting requirements regarding a move to IPCC2006.

Recommendations

It is recommended that the Agricultural Inventory Advisory Panel:

34. ***Agree** that the value used for methane emissions from enteric fermentation from swine be changed from the IPCC default to of 1.50 kg CH₄/head/yr to a country specific value of 1.06 kg CH₄/head/yr.*

Agree / not agreed

35. ***Agree** that the value used for methane emissions from manure management from swine be changed from the IPCC default to of 20.00 kg CH₄/head/yr to a country specific value of 5.94 kg CH₄/head/yr.*

Agree / not agreed

36. ***Agree** that the method used to determine the nitrogen excretion from swine be changed from using the 1996 IPCC default value of 16 kg N/head/yr to using the 2006 Tier 1 equation of $N_{ex} = N \text{ rate} \times TAM/1000 \times 365$.*

Agree / not agreed

37. ***Agree** that the data used in the N excretion equation agreed to in 41 be;*
 - *the population distribution as reported in Appendix 5 in the report and,*
 - *population numbers from Statistics NZ and,*
 - *the average weight as reported by the New Zealand Pork Industry Board.*

Agree / not agreed

38. ***Agree** that country specific manure management proportions be adopted as follows using the manure management systems detailed in either:*

The IPCC 2006 Guidelines

- i. Anaerobic Lagoons –20.5 percent of manure*
- ii. Daily spread – 25.7 percent of manure*
- iii. Direct to pasture – 8.9 percent of manure, accounted for in animal production*
- iv. Pit storage –13.1 percent of manure*
- v. Composting (passive windrow) – 3.0 percent of manure*

- vi. *Deep litter (no mixing) – 0.7 percent of manure*
- vii. *Deep litter (no mixing) + composting – 19.0 percent of manure*
- viii. *Deep litter (mixing) + composting – 6.7 percent of manure*
- ix. *Anaerobic Digester – 2.4 percent of manure*

Agree / not agreed

Or the 1996 IPCC Guidelines

- i. *Anaerobic Lagoons –20.5 percent of manure*
- ii. *Daily spread – 25.7 percent of manure*
- iii. *Direct to pasture – 8.9 percent of manure, accounted for in animal production*
- iv. *Solid storage and dry lot – 42.5 percent of manure*
- v. *Other – 2.4 percent of manure*

Agree / not agreed

39. ***Note** that due to the restrictions in implementing the 2006 IPCC guidelines changes to the methodology of indirect emissions from manure management and direct and indirect emissions from Agricultural soils (paragraph 37) will not be implemented.*

Noted

Andrea Pickering
Senior Policy Analyst

Approved/ Not Approved/ Approved as Amended

Alice Marfell-Jones
Manager Information and Analysis
Chair Agricultural Inventory Panel

Date