Peer review of NZ Pork emission guidelines

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PEER REVIEW OF NZ PORK EMISSIONS GUIDELINES

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Version 1 This is a draft report for client comment.

Version 2. Final report to client

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1 INTRODUCTION

New Zealand is required to calculate and report to the New Zealand Greenhouse Gas Inventory Report (NZ GHGIR) its GHG emissions under its obligations to the Kyoto Protocol. For the 2008 calendar year, the NZ pork industry calculated its total emissions as 190 Gg CO2-e or 5% of agricultural emissions. Due to its small contribution to the GHG profile, the New Zealand pork industry has been assigned default values provided by the Intergovernmental Panel on Climate Change (IPCC) for a majority of the calculations. Some categories have used NZ-specific data that has been extrapolated from other agricultural industries. This has resulted in a level of uncertainty of emission values provided in the GHGIR for the NZ pork industry.

This resulted in a project to develop accurate data for use in the GHGIR for the NZ pork industry. Milestone 1 of this project involved a literature review that identified a number of areas for further work:

1. Enteric fermentation – develop NZ specific for gross energy values for pigs.
2. Manure management CH_4 – develop values for fraction of manure entering each manure system, develop VS production for different pig classes and calculate manure management CH_4 emission factor.
3. Manure management direct N_20 emissions – develop values for fraction of manure N entering each manure system, develop N excretion rates for different pig classes and calculate NZ-specific manure management N_2O emission factor.
4. Manure management indirect N_20 emissions – quantify indirect N_2O emissions for NZ pork manure management systems.
5. Agricultural soils direct N_20 emissions – compare direct N_2O emissions from agricultural soils using current method applied to NZ GHGIR and IPCC (2006) methodology.
6. Agricultural soils indirect N_20 emissions – calculate N_2O emissions from volatilisation and leaching and runoff from agricultural soils.
7. Carbon offsetting plantings – calculate carbon offsets from forestry plantings in the pig industry.

Milestone 4 of this project developed a document that recalculated pork industry emissions for New Zealand based on the above areas. The New Zealand Ministry of Agriculture and Forestry (MAF) engaged FSA Consulting to conduct a peer review of this document.

The terms of reference for this work are:

- A review of the methodology and logic used.
- A review of the literature cited and comments on any significant omissions.
- Recommendations for any major changes.
- Comments on formatting and typographical issues.

The review does not include:

- Checking of pig numbers for New Zealand.
- Recalculation of any results provided in the report.

This report includes the findings of the review and has been divided into two main sections:

1. Review of emission factors, rates and methodology.
2. General editing - spelling, grammar and general comments.

2 REVIEW OF EMISSION FACTORS, RATES AND METHODOLOGY

This section covers the main technical component of the review: *Review of GHG emission factors, rates and methodology*. The modules covered are listed in Table 1. Findings of review for each module are presented in separate sections below in tabulated format to address the criteria sheet provided by MAF: *New Zealand Greenhouse Gas Inventory - Approval for change to emission factor, parameter or methodology*.

TABLE 1 – MODULES COVERED WITHIN THIS REVIEW.

Reviewer	FSA Consulting
Date of review	31 May 2011
Emission factors, rates and methodology reviewed	1. Enteric fermentation 2. Manure management: Methane (CH_4) 3. Manure management: Nitrogen excretion rates. 4. Manure management: Direct N_2O emissions 5. Manure management: Indirect N_2O emissions 6. Agricultural soils: Direct N_2O emissions 7. Agricultural soils: Indirect N_2O emissions (volatilisation) 8. Agricultural soils: Indirect N_2O emissions (leaching and runoff)

2.1 ENTERIC FERMENTATION

The enteric fermentation emission factor module was reviewed and Table 2 summarises the findings.

Detailed comments on whether the report sufficiently covers the topic and provides adequate justification for change to the emission factor for enteric fermentation is provided in Table 3.

TABLE 2 – SUMMARISED REVIEW OF ENTERIC FERMENTATION EMISSION FACTOR

Inventory sector	Agriculture: Pigs – enteric fermentation
Current value of emission factor, variable or methodology Tier	1.5 kg CH_4/hd/yr – Tier 1.
Suggested value of emission factor, variable or methodology Tier	1.06 kg CH_4/hd/yr – Tier 1, calculated from Tier 2 analysis.
Use from year (start year)	2009 – No data presented on GE values of diets before 2009 survey
Recommend that a change to the new value or methodology is approved	Yes – sufficient justification provided based on the data collected on weighted average GE values for diets fed to pigs in NZ.

TABLE 3 – JUSTIFICATION FOR CHANGE TO ENTERIC FERMENTATION EMISSION FACTOR

	Yes/no	Comment
Is the need for a change well documented?	Yes	Clear methodologies for changed values adopted are provided.
Is the proposed change scientifically defensible?	Yes	Large proportion of NZ pig industry surveyed. Sufficient data on GE diet values for NZ pork production provided. GE values checked with industry experts.
Has any documentation been peer-reviewed or published?	Yes	Methodology peer-reviewed by FSA Consulting (2011) – this report.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	It follows the methodology and equations presented in IPCC (2006). Tier 1 approach used as suggested by IPCC (2006), with Tier 2 methodology to calculate default emission factors.
Is any new EF, variable or methodology comparable with any other countries?	Yes	Based on IPCC (2006), the proposed EF falls within the uncertainty range of 1.5 kg CH_4/hd/yr (±30 - 50%).
Is the level of uncertainty reported?	No	Uncertainty values should be provided, using the range of GE values reported for various sites in Appendix 3.
Is there a comparison with IPCC default emission factors, variables or Tier 1 methodology?	Yes	Table provided on comparison between current default value and suggested value for years 1990 and 2009.

2.2 MANURE MANAGEMENT: METHANE

The methane emissions factor module for manure management was reviewed and Table 4 summarises the findings.

Detailed comments on whether the report sufficiently covers the topic and provides adequate justification for a change to the emission factor for methane from manure management is provided in Table 5.

TABLE 4 – SUMMARISED REVIEW OF THE METHANE EMISSION FACTOR FOR MANURE MANAGEMENT

Inventory sector	Agriculture: Pigs – Manure management methane
Current value of emission factor, variable or methodology Tier	20 kg CH_4/hd/yr – Tier 1.
Suggested value of emission factor, variable or methodology Tier	5.48 kg CH_4/hd/yr – Tier 1 based on a Tier 2 analysis.

Use from year (start year)	2009 – No survey data on percentage breakdown of each manure management system before 2009 provided.
Recommend that a change to the new value or methodology is approved	Yes – sufficient justification provided, based on the surveyed manure management systems in NZ and VS production rates for different classes of pig.

TABLE 5 – JUSTIFICATION FOR CHANGE TO THE METHANE EMISSION FACTOR FOR MANURE MANAGEMENT

	Yes/no	**Comment**
Is the need for a change well documented?	Yes	Clear methodologies for corrected values adopted are provided.
Is the proposed change scientifically defensible?	Yes	Large proportion of the NZ pig industry manure management practices surveyed. Estimated VS production rates for different classes of pigs justified and checked against literature values. However, (as noted by authors), uncertainty exists on the MCF' values for deep litter systems based on batch length. It is logical that methane emissions from pigs in deep litter is low provided the batch length of pigs is short (< 50 days), resulting in relatively dry litter that remains aerobic. This area requires further study.
Has any documentation been peer-reviewed or published?	Yes	Methodology peer-reviewed by FSA Consulting (2011) – this report.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	It follows the equations and methods presented in IPCC (2006). Tier 2 methodology used as suggested by IPCC (2006) for pigs.
Is any new EF, variable or methodology comparable with any other countries?	Yes	VS excretion rates adopted to calculate EF comparable to Australian research on VS excretion, except for farrowed sows (2.1% of pig population), where the value used is significantly higher. Similar to IPCC (2006) default values of VS excretion for all pig classes. Note: Adjusted MCF factor for deep litter pigs based on pig residence time on litter largely anecdotal, however a reasonable assumption to make that the system will not become anaerobic.
Is the level of uncertainty	No	Uncertainty values should be provided.

reported?		These will largely be dependent on MCF values adopted for major emission sources (anaerobic ponds and deep litter).
Is there a comparison with IPCC default emission factors, variables or Tier 1 methodology	Yes	Table provided on comparison between current default value and suggested value for years 1990 and 2009.

2.3 MANURE MANAGEMENT: NITROGEN EXCRETION EMISSION FACTOR

The emission factor for nitrogen excretion rate (used in calculation of direct and indirect N_2O emissions) was reviewed and Table 6 summarises the findings.

Detailed comments on whether the report sufficiently covers the topic and provides adequate justification for a change to the emission factor of nitrogen excretion is provided in Table 7.

TABLE 6 – SUMMARISED REVIEW OF THE NITROGEN EXCRETION EMISSION FACTOR

Inventory sector	Agriculture: Pigs – Nitrogen excretion emission factor
Current value of emission factor, variable or methodology Tier	16 kg N/hd/yr – Tier 1
Suggested value of emission factor, variable or methodology Tier	10.8 kg N/hd/yr – Tier 1
Use from year (start year)	2009 – No survey data on animal mass (to give N excreted values) prior to 2009 provided.
Recommend that a change to the new value or methodology is approved	Yes – sufficient justification provided based on the surveyed piggery populations and pig weight ranges for NZ pork production.

TABLE 7 – JUSTIFICATION FOR CHANGE TO THE NITROGEN EXCRETION EMISSION FACTOR

	Yes/no	Comment
Is the need for a change well documented?	Yes	Clear methodologies for updated values adopted provided.
Is the proposed change scientifically defensible?	Yes	Large proportion of NZ pig industry surveyed to obtain pig mass by class and subsequent excretion rate.
Has any documentation been peer-reviewed or published?	Yes	Methodology peer-reviewed by FSA Consulting (2011) – this report.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	It follows the methodology presented in IPCC (2006). Tier 1 approach used as suggested by IPCC (2006) for pigs.

		Tier 2 approach using mass balance may produce lower numbers than that predicted for breeding pigs, thus values adopted are likely to be conservative.
Is any new EF, variable or methodology comparable with any other countries?	Yes	Estimated N excretion rates for growing pigs aligns with literature cited. For breeder pigs there is a large range in reported values, however, selected values (based on animal mass) are conservative based on mass balance studies in Australia.
Is the level of uncertainty reported?	No	Uncertainty values should be reported for likely variations in N excretion rates.
Is there a comparison with IPCC default emission factors, variables or Tier 1 methodology	Yes	Table provided on comparison between current default value and suggested default values using IPCC (1996) and IPCC (2006) Tier 1 methodologies.

2.4 MANURE MANAGEMENT: DIRECT NITROUS OXIDE EMISSION RATE

The emission rate of direct N_2O from manure management was reviewed and Table 8 summarises the findings.

Detailed comments on whether the report sufficiently covers the topic and provides adequate justification for a change to the emission rate for direct N_2O from manure management is provided in Table 9.

TABLE 8 – SUMMARISED REVIEW OF THE DIRECT N_2O EMISSION RATE FOR MANURE MANAGEMENT

Inventory sector	Agriculture: Pigs – Manure management direct nitrous oxide
Current value of emission factor, variable or methodology Tier	Total emissions = 43420 kg N_2O/yr – Tier 1
Suggested value of emission factor, variable or methodology Tier	Total emissions = 53617 kg N_2O/yr - – Tier 2 as NZ-specific N excretion rates used
Use from year (start year)	2009 – No data on animal mass (N excreted) prior to 2009.
Recommend that a change to the new value or methodology is approved	Yes – sufficient justification provided based on the surveyed piggery populations and weight ranges for NZ pork production to give N excretion rates and partitioning of N to various manure management systems. However, may need to review partitioning of N to various MMS's

	based on number of pigs in each class contributing to each MMS category. E.g Only 1% of breeder pigs on deep litter, compared to ~30% of growing pigs.

TABLE 9 – JUSTIFICATION FOR CHANGE TO THE N_2O DIRECT EMISSION RATE FOR MANURE MANAGEMENT

	Yes/no	Comment
Is the need for a change well documented?	Yes	Clear methodologies for corrected values adopted are provided.
Is the proposed change scientifically defensible?	Yes	Large proportion of the NZ pig industry manure management practices surveyed. Estimated N excretion rates for different classes of pigs justified and checked against literature values. Proportion of N to various manure management systems based on survey data and literature values of N separation efficiency.
Has any documentation been peer-reviewed or published?	Yes	Methodology peer-reviewed by FSA Consulting (2011) – this report.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	It follows the equations and methodology presented in IPCC (2006). Tier 1 method for N_2O direct emission factors adopted from IPCC (2006).
Is any new EF, variable or methodology comparable with any other countries?	Yes	N excretion rates used to calculate EF comparable to Australian research. Survey completed to estimate manure N managed in various systems. Tier 1 method for N_2O direct emission factors adopted from IPCC (2006) to calculate total emissions for NZ as per IPCC methodology.
Is the level of uncertainty reported?	No	Uncertainty values should be provided. These will largely be dependent on uncertainty values as reported by IPCC (2006) for N_2O emissions for various MMS's.
Is there a comparison with IPCC default emission factors, variables or Tier 1 methodology	Yes	IPCC (2006) default emission factors adopted to give total emissions for NZ pork production.

2.5 MANURE MANAGEMENT: INDIRECT NITROUS OXIDE EMISSION RATE

The emission rate of indirect N_2O from manure management was reviewed and Table 10 summarises the findings.

Detailed comments on whether the report sufficiently covers the topic and provides adequate justification for a change to the emission rate for indirect N_2O from manure management is provided in Table 11.

TABLE 10 – SUMMARISED REVIEW OF THE INDIRECT N_2O EMISSION RATE FOR MANURE MANAGEMENT

Inventory sector	Agriculture: Pigs – Manure management indirect nitrous oxide
Current value of emission factor, variable or methodology Tier	NA – previously methodology did not account for this emission
Suggested value of emission factor, variable or methodology Tier	Total emissions = 15056 kg N_2O/yr -– Tier 2, as NZ-specific N excretion rates used.
Use from year (start year)	2009 – No data on animal mass (N excreted) prior to 2009.
Recommend that a change to the new value or methodology is approved	Yes – sufficient justification provided based on the surveyed piggery populations and weight ranges for NZ pork production to give N excretion rates and N losses from various MMS's based on IPCC (2006).

TABLE 11 – JUSTIFICATION FOR CHANGE TO THE INDIRECT N_2O EMISSION RATE FOR MANURE MANAGEMENT

	Yes/no	Comment
Is the need for a change well documented?	Yes	Clearly documented process for additional values using IPCC (2006) methodology provided.
Is the proposed change scientifically defensible?	Yes	Large proportion of the NZ pig industry manure management practices surveyed. Estimated N excretion rates for different classes of pigs justified and checked against literature values.
Has any documentation been peer-reviewed or published?	Yes	Methodology peer-reviewed by FSA Consulting (2011) – this report.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	Proportion of N volatilised from various manure management systems based on IPCC (2006) default values. Emission factor for redeposited N based

		on IPCC (2006) default value.
Is any new EF, variable or methodology comparable with any other countries?	Yes	N excretion rates used to calculate EF comparable to Australian research. Survey completed to estimate manure N managed in various systems. IPCC (2006) values adopted for N volatilised from various manure management systems. Default emission factor - EF_4 from IPCC (2006) adopted.
Is the level of uncertainty reported?	No	Uncertainty values should be provided. These will largely be dependent on N loss due to type of MMS used. IPCC (2006) provides uncertainty ranges for these.
Is there a comparison with IPCC default emission factors, variables or Tier 1 methodology	Yes	IPCC (2006) Tier 1 and Tier 2 comparisons provided. IPCC (2006) default N loss and emission factor (EF_4) adopted to give total emissions for NZ pork production.

2.6 AGRICULTURAL SOILS: DIRECT N_2O EMISSION RATE

The emission rate of direct N_2O from agricultural soils was reviewed and Table 12 summarises the findings.

Detailed comments on whether the report sufficiently covers the topic and provides adequate justification for a change to the direct N_2O emission from agricultural soils is provided in Table 13.

TABLE 12 – SUMMARISED REVIEW OF THE N_2O DIRECT EMISSION RATE FOR AGRICULTURAL SOILS

Inventory sector	Agriculture: Pigs – Agricultural soils direct nitrous oxide
Current value of emission factor, variable or methodology Tier	Total emissions = 89315 kg N_2O/yr – Tier 1
Suggested value of emission factor, variable or methodology Tier	Total emissions = 34817 kg N_2O/yr - – Tier 2, as NZ-specific N excretion rates used.
Use from year (start year)	2009 – No data on animal mass (N excreted) prior to 2009.
Recommend that a change to the new value or methodology is approved	Yes – sufficient justification provided based on new IPCC (2006) methodology to account for total N loss from various MMS's before land application. Application of NZ specific emission

	factors for direct emissions from organic application (EF_1=0.01) and direct application of manure (EF_3=0.01) applied to provide total emission rate for NZ pork production.

TABLE 13 – JUSTIFICATION FOR CHANGE TO THE N_2O DIRECT EMISSION RATE FOR AGRICULTURAL SOILS

	Yes/no	Comment
Is the need for a change well documented?	Yes	Clear documentation of IPCC (2006) methodology using country specific emission factors. Reduced emission rates based on mass balance principles of N partitioning through the system as per IPCC (2006).
Is the proposed change scientifically defensible?	Yes	Change is based on current – IPCC (2006) methodology and country specific data from research of N_2O emission factors from agricultural soils. Authors acknowledge wide variability in results of emission rates and the factors that affect these.
Has any documentation been peer-reviewed or published?	Yes	Methodology peer-reviewed by FSA Consulting (2011) – this report.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	Methodology and emission factors used follow IPCC (2006) methodology.
Is any new EF, variable or methodology comparable with any other countries?	Yes	N loss rates to calculate N application rates adopted from IPCC (2006) default values within the range of reported literature. Emission factors comparable with limited research available.
Is the level of uncertainty reported?	No	Uncertainty values could be provided. This uncertainty could be based on the range of reported N loss rates to give N application rates, combined with range in likely emission factors for organic fertiliser application and direct manure application.
Is there a comparison with IPCC default emission factors, variables or Tier 1 methodology	Yes	Comparison provided for IPCC (2006) and IPCC (1996) guidelines for direct N_2O emissions for 2009 and 1990 years.

2.7 AGRICULTURAL SOILS: INDIRECT N_2O EMISSION RATE (VOLATILISATION)

The emission rate of indirect N_2O from agricultural soils (volatilisation) was reviewed and Table 14 summarises the findings.

Detailed comments on whether the report sufficiently covers the topic and provides adequate justification for a change to the indirect N_2O emission from agricultural soils (volatilisation) is provided in Table 15.

TABLE 14 – SUMMARISED REVIEW OF THE N_2O INDIRECT EMISSION RATE FOR AGRICULTURAL SOILS (VOLATILISATION)

Inventory sector	Agriculture: Pigs – Agricultural soils indirect nitrous oxide (volatilisation)
Current value of emission factor, variable or methodology Tier	8116 kg N_2O/yr – Tier 1 (2007 NZ GHGIR).
Suggested value of emission factor, variable or methodology Tier	3482 kg N_2O/yr - Tier 2, as NZ-specific N excretion rates used.
Use from year (start year)	2009 – No data on animal mass (N excreted) prior to 2009.
Recommend that a change to the new value or methodology is approved	Yes – sufficient justification provided based on IPCC (2006) methodology, with use of NZ specific emission N losses from application of manure N.

TABLE 15 – JUSTIFICATION FOR CHANGE TO THE N_2O INDIRECT EMISSION RATE FOR AGRICULTURAL SOILS (VOLATILISATION)

	Yes/no	Comment
Is the need for a change well documented?	Yes	Clear documentation of IPCC (2006) methodology using country specific N loss rates. Reduced emission rates based on mass balance principles of N partitioning through the system as per IPCC (2006).
Is the proposed change scientifically defensible?	Yes	Change is based on current IPCC (2006) methodology and NZ specific data from research of N loss from manure application. Authors acknowledge wide variability in results of N loss rates.
Has any documentation been peer-reviewed or published?	Yes	Methodology peer-reviewed by FSA Consulting (2011) – this report.
Is the proposed methodology, EF or variable consistent with	Yes	Methodology follows IPCC (2006). Emission factors of N loss follows NZ-specific data as per IPCC (2006)

IPCC GPG?		methodology.
Is any new EF, variable or methodology comparable with any other countries?	Yes	N emission rates comparable with research on N loss rates reported. Authors acknowledge lack of data on N loss rates from application of solid manure forms derived from pigs.
Is the level of uncertainty reported?	No	Uncertainty values should be provided. This uncertainty should be based on the range of reported N volatilisation loss rates, combined with reported range in IPCC (2006) EF_4 emission rates.
Is there a comparison with IPCC default emission factors, variables or Tier 1 methodology	Yes	Comparison provided for IPCC (2006) and IPCC (1996) guidelines for indirect N_2O emissions for agricultural soils (volatilisation) for 2009 and 1990 years.

2.8 AGRICULTURAL SOILS: INDIRECT N_2O EMISSION RATES (LEACHING AND RUNOFF)

The emission rate of indirect N_2O from agricultural soils (leaching and runoff) was reviewed and Table 16 summarises the findings.

Detailed comments on whether the report sufficiently covers the topic and provides adequate justification for a change to the indirect N_2O emission rate from agricultural soils (leaching and runoff) is provided in Table 17.

TABLE 16 – SUMMARISED REVIEW OF N_2O INDIRECT EMISSION RATE FOR AGRICULTURAL SOILS (LEACHING AND RUNOFF)

Inventory sector	Agriculture: Pigs – Agricultural soils indirect nitrous oxide (volatilisation)
Current value of emission factor, variable or methodology Tier	14202 kg N_2O/yr – Tier 1 - (2007 NZ GHGIR)
Suggested value of emission factor, variable or methodology Tier	1828 kg N_2O/yr - Tier 2, as NZ-specific N excretion rates used and NZ-specific N loss rates.
Use from year (start year)	2009 – No data on animal mass (N excreted) prior to 2009.
Recommend that a change to the new value or methodology is approved	Yes – sufficient justification provided based on IPCC (2006) methodology, with use of NZ specific emission N losses through leaching and runoff.

TABLE 17 – JUSTIFICATION FOR CHANGE TO N_2O INDIRECT EMISSION RATE FOR AGRICULTURAL SOILS (LEACHING AND RUNOFF)

	Yes/no	Comment
Is the need for a change	Yes	Clear documentation of IPCC (2006)

well documented?		methodology using NZ specific N loss rates for leaching and runoff. Reduced emission rates based on mass balance principles of N partitioning through the system as per IPCC (2006).
Is the proposed change scientifically defensible?	Yes	Change is based on current IPCC (2006) methodology and NZ specific data from research of N loss from leaching and runoff from agricultural soils.
Has any documentation been peer-reviewed or published?	Yes	Methodology peer-reviewed by FSA Consulting (2011) – this report.
Is the proposed methodology, EF or variable consistent with IPCC GPG?	Yes	Methodology follows IPCC (2006). Emission factors of N loss in leaching and runoff from NZ-specific data as per IPCC (2006) Tier 2.
Is any new EF, variable or methodology comparable with any other countries?	Yes	NZ-specific data for N loss in leaching and runoff factor lower than IPCC (2006) reported range, however based on research and modelling.
Is the level of uncertainty reported?	No	Uncertainty values should be provided. This uncertainty should be based on the range of reported N loss in leaching and runoff as reported by Thomas et al (2005), combined with reported range in IPCC (2006) EF_5 emission rates.
Is there a comparison with IPCC default emission factors, variables or Tier 1 methodology	Yes	Comparison provided for IPCC (2006) and IPCC (1996) guidelines for indirect N_2O emissions for agricultural soils (leaching and runoff) for 2009 and 1990 years.

2.9 SUMMARY OF EMISSION FACTORS, RATES AND METHODOLOGY

In general, the modules reviewed meets the requirements of the New Zealand Greenhouse Gas Inventory approval guidelines for a change to emission factor, parameter or methodology. One criteria missing in each module is the levels of uncertainty of the data provided. These levels of uncertainty can be obtained from the IPCC (2006) guidelines values or NZ-specific values from research and modelling.

Additionally, the report lacks clarity on what the current emission rates are for each category and the new emission rates adopted. The summary tables at the end of each module list a number of emission rates for NZ pork production. These summary tables often list values using IPCC (1996), IPCC (2006), Tier 1 and Tier 2 over calendar years 1990 and 2009.

The methodology generally uses a Tier 2 approach to calculate a Tier 1 emission factor that is then applied. It is assumed that a detailed spreadsheet has been developed that can be updated and used to reflect changes in herd size, management, new research etc. Where applicable, it would be worth consideration of applying a Tier 2 methodology alone to

estimate emissions, rather than calculating a new Tier 1 factor from the Tier 2 methodology. This would overcome the issue of changes in herd management in relation to different MMS's. For example, sows being moved to bedding from conventional flushed sheds.

3 GENERAL EDITING

3.1 SPELLING, GRAMMAR AND GENERAL COMMENTS

There are numerous editing errors within the report, with specific examples detailed below in Table 18 below. General comments regarding written component of the report include:

- There are too many errors to show corrections for all, so some examples are given. Details of units are not consistent throughout the report. One space should be kept between reported values and units, with the exception of %. Spaces should also be kept between units (e.g. kg CH_4 animal^{-1} yr^{-1}). All units should be in lower caps (e.g. kg, not Kg).
- Remove unnecessary caps throughout report.
- Errors regarding referencing, both within text references and in the reference list (see Section 3.2.

TABLE 18 – SPELLING, GRAMMATICAL AND GENERAL COMMENTS RELATED TO WRITING

Page number	Paragraph	Description
6	5	Spelling. Correct *onfarm* to *on-farm*.
9	6	Sentence 1, poor sentence structure. Suggested: change *"…56 of NZ pork production*" to *"…56 of NZ pork producers*"
11	2	Sentence 1. Insert missing space following, remove capital "*S*" in "*Statistics*"
14	2	*Commercial* does not require capital letter.
15	2	Sentence 1 is incomplete, sentence does not make sense.
15	5	Poor sentence structure, recommendation is unclear.
15	Section 3.2	Consistency required i.e *New Zealand-specific*, *NZ specific*, also what is EF abbreviated for? In title it is assumed it is enteric fermentation, but it text it is abbreviated for emission factor.
16	Equation 1	Check definition for Ym. *Ym = methane conversion rate expressed in a decimal form*. In equation it is divided by 100 to get to decimal form.
17	Table header	Table 6 should specify "enteric methane" within the title. Also, *Emission* does not require capital.
17	2	Sentence 4: words missing, Sentence 5: change to *"…finisher diet had calculated emission of 1.55 kgCH_4…*"
17	3	Sentence 1: remove duplicated "*kg*"
17	5	Sentence 2: correct spelling of "value"
18	1	Should read *...for the calendar years 1990 and 2009....*
18	Table 7	Column 4 heading should read "*Emissions from **enteric** fermentation (Gg)*"
18	Table 8	Has additional 0.00 in column 6.
19	Table 9	Column 3 heading should read "*Emissions from **enteric***

		fermentation (Gg)"
20	7	Delete "*agricultural emissions*", replace with "*pork emissions*"
21	4 (dot point a)	Are all NZ liquid based systems "pull plug". I assume some would be daily flush, some maybe static pits?
23	3	Not sure that the assumption could be made that the 30 days as specified could be for the reason stated. It maybe for instance that the <30 days is for farrowing on deep litter?
23	4	Final sentence: Replace "*As a result an MCF…"* with "*As a result, a MCF…"*
23	5	Sentence 2: replace "…*aerating the material.*" to "…and provides aeration.*"*
25	2	Formatting: change all formatting to black font colour
25	Table 13	It is not clear what *Composting Passive Windrow* is. This would be normally be secondary treatment. It is assumed it refers to separated solids that are then composted – this should be stated more clearly.
25	6	Delete full-stop: ("*AWMS.*"). Spelling: "*rage*" to "*range*"
26	1	Sentence 1: change: "*…is comprised largely of…"* to "*is comprised of…*"
26	Equation 5 and 6	Correct "*VS (kgdm/ day)…*" to "*VS (kg day^{-1})??…*"Definition states that it is dry basis.
27	3	Sentence 1: correct units from "*0.5kgVShead^{-1} day $^{-1}$*" to "*0.5 kg VS head^{-1} day $^{-1}$*". Correct other spacings and erroneous caps for units on page 27, paragraphs 3 and 4
28	1	Correct spacings for units
28	1	Delete repeated "indicate/indicated"
28	2	This paragraph reads like all categories out by a factor of 2, not just farrowed sows. Suggest rewording to make clearer.
28	7	Remove caps on "*In-Vessel Composting*" and "*Composting Passive Window*"
29	5	Correct sentence: "*…anaerobic lagoons to emissions to produce…*" to "*…anaerobic lagoons to produce…*"
31	Figure 4	Correct legend for Figure 4. 119 and 2006 not required, as already referenced in brackets.
31	5	Remove double *%%*
32	2	Reads "...*for the 2009 calendar*,...", Should read "...for the 2009 calendar year,..."
32	2, 4, 5 6	Correct spacings for units, including consistency for percentage (%)
33	1	Remove double full-stop at end of paragraph. Correct spacings for units
34	1, 5	Correct spacings for units Spelling: "*kg CH_4 animal^{-1} yr^{-1}*" not "*kg CH_4 aniaml^{-1} yr^{-1}*"
34	2 – dot point 1	States 68% of NZ's pork farms. Page 9 says 67% of NZ's pork production. Correct this and check consistency in percentages and what percentage refers

		to – *pork farms* OR *pork production* throughout document.
35	All	Correct spacings for units throughout page.
35	Eqn 10 description	Remove unnecessary caps. "*market pig 0.53*" and "*breeding 0.46 kg N*"
36	4 (last)	Sentence one reads: "... *calculated based NZPork (2009)*...", should read: ".. *calculated based on NZPork (2009)* ."
38	3	Final sentence. Spelling: "*solids"* instead of "*soils*" Spelling: "*values*" instead of "*valued*".
38	5	Sentence 3. "…*IPCC use a slightly*…" instead of "…*IPCC use slightly*…"
38	6	Last sentence specifies that deep litter material is "*often turned*". Does this refer to turning by pigs in the shed or mechanically post shed clean out?
39	Table 24	"*Composting passive windrow*" should also refer to "*screening with solids separator*".
40	Table 25	Dry Lot should be 0.02.
41	Table 27	Headings in Columns 1 and 3 have superscript notes 1 and 4, however these are not referred to under the table. Consistency required in decimal points in totals. Should table heading be similar to table heading 30, i.e. "Di*rect N_2O emissions for AWMS treating pig derived manure 1990 and 2009*"
42	2	Use word "*estimated*", rather than "*recorded*".
42	Table 28	Table 22 says 10.8? Check which value calculations have been done on. Question whether a straight average can be used here, as survey (Appendix 5) reports only 1% breeding animals on straw, compared with ~30% of growing animals. Values should be calculated on pig class corresponding to MMS. This is an artefact of using Tier 2 methodology to develop a new Tier 1 EF.
42	3	Should read *"…. that the rate **is** 29%"*.
43	Dot point 1	Use value "10.8", instead of "10.816". Tables and other text use one decimal place.
43	3 (Sentence 1)	Full stop required after GHGIR.
43	1	Use word "*accounts*", instead of "*account"*.
43	Sections 5.5 and 5.6	Check consistency here between use of NH_3 and NH_4. NH_3 is gas form.
44	4 (last)	Normal to write ammonia-nitrogen as "*NH_3-N*", not "*N-NH_3*" – see line above. Also applicable to NOx. Also in other sections (5.6.4) – check consistency. Should be ammonia (*NH_3*) emissions, not *NH_4*.
45	Table 30	Should table heading read: "*Indirect N_2O emissions for AWMS treating pig derived manure 1990 and **2009***"
45	2 (5.6.3)	Comma after manure management,

47	3	It is unlikely that secondary pig ponds would be aerobic due to the high organic matter loading rates unless they are mechanically aerated.
47	6	Delete words: *"applied to"*
49	2	Comma after NZGHIR
54	5	Full stop at beginning of sentence
54	Equation 19	Should be 44/28 to convert N_2O-N to N_2O.
56	Table 36	Reword heading: "*In direct*" to "*Indirect*" Capital K not required for kg.
57	Equation 22 explanation	Frac $_{LEACH-(H)}$ – NZ specific value should be 0.07, not 0.07%?
57	Last paragraph	IPCC (2006) uses range 0.1 – 0.8, not 0.01 – 0.8.
58	Table 37	Heading - Capital K not required for kg.
64	3	Spelling: "*Emissions*"
65	1 (end)	Double full-stop

3.2 REFERENCING ERRORS

Many errors regarding referencing have been observed within the report. Some of these are detailed below. It is recommended that the authors undertake a thorough proofing of all references and in-text citations. Authors are advised to consider use of software referencing software, e.g. EndNote.

A large number of inconsistencies were observed in the formatting within the reference list. For e.g., Australian Journal of Soil Research has also been referenced as Aust. J. Soil Res. Errors also exist in the in-text citations require correction, for e.g. Clarke *et al.* 2004 (in-text) is spelt "Clark" (2004) within the reference list. Similar errors are highlighted for Zang and Western (1997) [incorrect], spelt correctly as "Westerman" within text (pp. 21, 22). In-text citation of FSA Consulting (2007) on page 27/28 is incorrect, and is currently included as "*FSA Consultants in 2007*".

In-text citation errors and inconsistencies need to be corrected. For e.g., citations within paragraph 3, page 13 (Farran et al. 2000) and (Clarke *et al.* 2004). Safley and Westerman (1990) is cited incorrectly (spelling) on page 25 (paragraph 8). Heubeck and Craggs, 2010; comma misplaced, paragraph 4, pg 29.

Kruger et al. (1995), APL (2006), ASAE (2005) MWPS (1993) are not included in reference list.

Include year of publication for all in-text citations. For e.g. citation included in sentence 1, page 11, paragraph 2 does not include publication year.