MPI Policy and Trade
Agricultural Inventory Advisory Panel Meeting
29 October 2019

Revisions to the National Inventory Model for New Zealand Goats

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Main Purpose: ☑ Decide ☑ Discuss ☑ Note

Purpose of this paper

1. To seek a recommendation from the Panel to use updated emission factors, parameters and methodologies for calculating greenhouse gas emissions from goats, namely:

    - The establishment of three subcategories in the goat inventory based on their productive use; dairy, meat and fibre.
    - New estimates of the population of dairy, fibre and meat goats since 1990 (as a proportion of the total farmed goat population).
    - New emission factors for enteric fermentation for dairy, fibre and meat goats
    - New nitrogen excretion (N_{ex}) values for dairy, fibre and meat goats
    - New faecal dry matter (FDM) production values for dairy, fibre and meat goats
    - the use of a new methodology for calculating manure management emissions from goats, and assumptions on the proportion of manure going to different manure management systems for dairy goats

2. The inventory changes proposed in this paper are in line with the tier 1 recommendations proposed in the report by Burggraaf et al (2019).The following documents are attached to this paper:

    a. Burggraaf, V., Rollo, M., de Klein, C., Luo, J. 2019. (unpublished) *A review of greenhouse gas emissions inventory methodology for farmed goats in New Zealand.*

b. Review of *A review of greenhouse gas emissions inventory methodology for farmed goats in New Zealand* by Garry Waghorn

c. The inventory change approval form completed by Garry Waghorn

3. These changes will increase the accuracy of emissions reporting, by more accurately reflecting trends and practices in the goat farming industry. The goat emissions inventory was last updated in 2012, following research by Lassey (2011)[1].

Background

4. As part of its obligations under the United Nations Framework Convention on Climate Change (UNFCCC) New Zealand is required to report on its emissions of farmed goats. Biological emissions from goats include methane (from enteric fermentation and manure) and Nitrous oxide (from manure deposited during grazing and during the storage of manure in manure management systems).

5. The farmed goat population in New Zealand has decreased significantly since 1990 from 1,062,900 in 1990, to 88,828 in 2018 (Statistics New Zealand, 2019). These goats are either farmed for meat, fibre or milk. Research from Burggraaf et al (2019) suggests that the population of meat and fibre goats has decreased significantly since 1990, while the population of dairy goats has increased.

6. Emissions from goats were estimated to be 27.4 kt CO_2-e in 2017, which is 0.07% of New Zealand's total agricultural emissions.

Current methodology

7. Emissions from goats are currently estimated using a tier 1 methodological approach, with country-specific emission factors and parameters developed by Lassey (2011). Activity data on the total goat population is sourced from Statistics New Zealand.

8. In the current inventory, a weighted emission factor for enteric fermentation (kg CH4 per goat per year, EF_{Goats}) is calculated based on the estimated proportion of dairy goats in the overall population. A similar calculation is used to estimate N_{ex} (kg N per goat per year). While the inventory weights EF_{Goats} and N_{ex} per goat based on the estimated proportion of dairy goats, there is no explicit separation between dairy and other goats.

9. The current inventory assumes that all goat manure (including manure from dairy goats) is deposited onto pasture. An IPCC default emission factor of 0.2 kg CH_4 per goat per year is used to estimate methane emissions from manure management. Direct nitrous oxide emissions from agricultural soils are estimated using an emission factor (EF_{3PRP}) value of 1 per cent. The parameters and emission factors

[1] Lassey K. 2011. *Methane Emissions and Nitrogen Excretion Rates for New Zealand Goats*. Report for the Ministry of Agriculture and Forestry, National Institute of Water and Atmospheric Research. Wellington: National Institute of Water and Atmospheric Research.

used to calculate indirect agricultural soils emissions is consistent with the rest of the inventory.

Proposed change – Separation of goat emissions by industry

10. It is proposed that three goat subcategories based on productive use are established for the goat inventory; dairy, meat and fibre. This classification will allow for differences across the goat class assumptions and resulting emission calculations due to production demands.

11. It is recommended that tier 1 methods still be used to calculate emissions from goats due to the small contribution of goat emissions to the overall inventory, and the lack of detailed production data on the goat industry.

12. Statistics New Zealand would still be used to provide estimates for the total goat population, but these estimates would then be split into dairy, fibre and meat goat estimates based on the research by Burggraaf et al (2019).

Table 1: Comparison of current and proposed goat populations, split by industry

	Current inventory	Proposed goat population split by industry			Total goat population
Year	Dairy goats	Dairy goats	Fibre goats	Meat goats	
1990	37,426	31,887	515,507	515,507	1,062,900
2005	30,738	52,482	41,819	41,819	136,120
2017	25,387	67,721	16,678	16,678	101,076
Percentage change 1990-2017	-32%	112%	-97%	-97%	-90%

13. Statistics New Zealand does not have data on the population breakdown of dairy, meat and fibre. Burggraaf et al (2019), assumed that dairy goats made up 3 per cent of the total goat population in 1990, with this proportion increasing linearly to 67 by 2017. The remaining population was assumed to be split equally between meat and fibre goats.

14. Under the proposed changes, separate assumptions on:

- Annual enteric fermentation per goat per year;
- Annual nitrogen excretion per goat per year; and
- Annual faecal dry matter per goat per year

would be used for dairy, meat and fibre goats, based on the research by Burggraaf et al (2019). The tables in the appendix detail the specific values for each year.

Proposed change – emissions from manure management

15. The tier 1 changes recommended by Burggraaf et al (2019) would significantly change the calculation of manure management and agricultural soils emissions.

Manure management and agricultural soils emissions for meat and fibre goats

16. For meat and fibre goats, methane emissions from manure management would be calculated using assumptions on faecal dry matter per goat, per year from Burggraaf et al (2019), along with the methane yield value for sheep manure, (set at 0.000691 kg CH_4/kg faecal DM).

17. The methodology used to calculate nitrous oxide emissions from agricultural soils would remain the same, although different nitrogen excretion values (as mentioned earlier) would be used.

Manure management and agricultural soils emissions for dairy goats

18. The inventory currently assumes that all goats (including dairy) spend 100 per cent of their time on pasture land and are not housed. Under the proposed methodology, all dairy goat manure would be deposited in a barn (96.5%) or during milking (3.5%). Figure 2 in the appendix summarises the different pathways for dairy goat manure and the nitrous oxide emissions that arise from these different pathways. The table below summarises the proportions of manure entering different manure management systems, and the per-goat methane emissions from these different systems.

Table 2: Proportion of dairy goat faecal dry matter entering different manure management systems for 2017 and methane emissions per head

Manure management system	Proportion of total dairy goat faecal DM	Methane yield (g/kg FDM)	Annual methane (kg/goat/year)
Dairy shed effluent, no storage	0.035 x 0.5 = 0.0175	0.691	0.00189
Dairy shed effluent, with storage	0.035 x 0.5 = 0.0175	82.1	0.224
Barn manure, no storage	0.965 x 0.5 = 0.4825	0.691	0.052
Barn manure, with storage (4 months)	0.965 x 0.5 = 0.4825	2.764	0.208
TOTAL	**1**		**0.486**

Effect of proposed improvements on inventory

19. Table 3 shows how the new emission factors, if implemented in the inventory, would affect estimated agricultural emissions in 1990 and 2017.

20. When looking solely at goat emissions, the implementation of the change has a large effect on the estimates of emissions from goats, especially in latter years as the proportion of dairy goats increase. Compared to the status quo, estimated emissions from goats would be around 2.65 kt CO_2-e (1.0%) higher in 1990 and 29.6 Mt CO_2-e (107.9%) higher in 2017. The large change in the estimated dairy goat population between the current and proposed methodology helps explain why there is a large difference in 2017's estimated goat emissions compared to 1990.

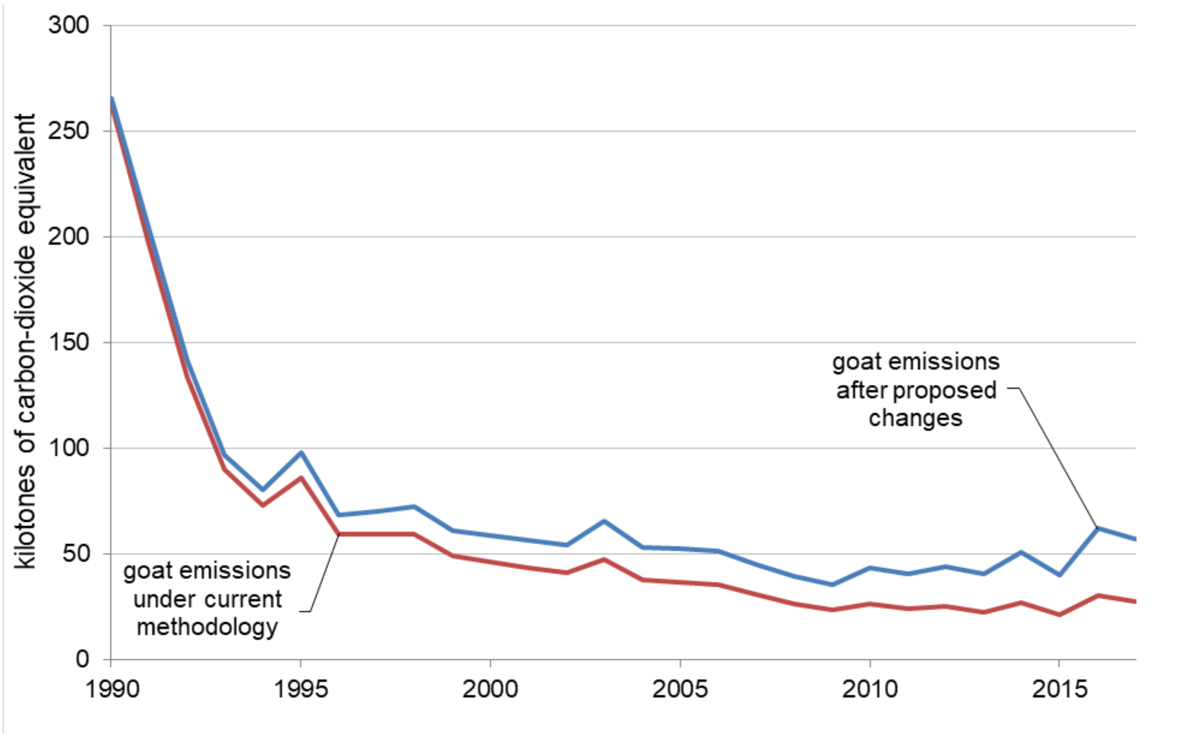
21. However, the implementation of these changes has a small impact on total agricultural emissions estimates. After the change is applied, estimated total

agricultural emissions in 2017 are around 0.08% (29.6 kt CO_2-e) higher, compared to emissions estimates in the current inventory (see table below).

Table 3: Comparison of current and previous emissions estimates before and after proposed goat inventory changes

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 goats (kt CO_2-e)	2019 (1990-2017) emissions estimate *without* change	262.76	27.44	-235.32	-89.6%
	2019 (1990-2017) emissions estimate *with* change	265.41	57.04	-208.37	-78.5%
	Difference in emission estimates compared to current inventory	2.65	29.60	26.95	
	Percentage difference in emission estimates	1.0%	107.9%		
Total emissions from Agriculture (kt CO_2-e)	2019 (1990-2017) emissions estimate *without* change	34,257	38,881	4,623	13.5%
	2019 (1990-2017) emissions estimate *with* change	34,260	38,910	4,650	13.6%
	Difference in emission estimates compared to current inventory	2.65	29.60	26.95	
	Percentage difference in emission estimates	0.01%	0.08%		

Figure 1: Estimated goat emissions before and after proposed changes



Reviewer comments

22. An independent review of the Burggraaf et al (2019) paper (and its associated recommendations) was undertaken by Garry Waghorn. Garry recommended that the changes proposed in the paper are approved.

Opportunities and risks

23. Changes to country-specific methodologies and/or emission factors are heavily scrutinised by an expert review team under the United Nations Framework Convention on Climate Change (UNFCCC), and there is a small risk that the UNFCCC will recommend that this team revert back to using the current methodology and parameters. However, this risk is alleviated by the intention to apply the new methodology consistently across the time series, and that there is peer-reviewed research associated with the new methodology.

24. Under the UNFCCC, countries should consider ways to improve their inventory. New Zealand is demonstrating that it is meeting its UNFCCC obligations by continuing to develop new methodologies that best suits its circumstances.

25. The implementation of these corrections and improvements will lead to a more accurate inventory, which in term will improve the development of climate change policy and the prioritisation of future research.

Next steps

26. If approved, the improvements discussed in this paper will be implemented in the 2020 version of the inventory.

Ministry for Primary Industries
Manatū Ahu Matua

Recommendations

The Agricultural Inventory Advisory Panel recommend that the tier 1 goat inventory methodology proposed in the paper by Burggraaf et al (2019), be adopted, namely:

27. Three subcategories in the inventory model be established for goats;

28. New emission factors and parameters for enteric fermentation, nitrogen excretion and faecal dry matter be used; and

29. Adopting a new methodology for calculating manure management emissions from goats, and assumptions on the proportion of manure going to different manure management systems for dairy goats.

Agree / not agreed

Approved/ Not Approved/ Approved as Amended

Gerald Rys
Principal Science Advisor, Science and Skills Policy
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Date

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Appendix

Table 4: Current and proposed enteric methane values (kg CH4/goat/year)

Year	Current value	Proposed values		
		Dairy	Meat	Fibre
1990	7.4	12.7	7.3	7.3
1991	7.4	12.8	7.3	7.3
1992	7.5	12.8	7.3	7.3
1993	7.6	12.9	7.3	7.3
1994	7.7	13.0	7.3	7.3
1995	7.6	13.1	7.3	7.3
1996	7.8	13.1	7.3	7.3
1997	7.8	13.2	7.3	7.3
1998	7.8	13.3	7.3	7.3
1999	7.9	13.3	7.3	7.3
2000	7.9	13.4	7.3	7.3
2001	8.0	13.5	7.3	7.3
2002	8.0	13.5	7.3	7.3
2003	7.9	13.6	7.3	7.3
2004	8.0	13.7	7.3	7.3
2005	8.1	13.8	7.3	7.3
2006	8.1	13.8	7.3	7.3
2007	8.2	13.9	7.3	7.3
2008	8.3	14.0	7.3	7.3
2009	8.5	14.0	8.2	7.5
2010	8.3	14.1	9.1	7.7
2011	8.4	14.2	10.0	7.8
2012	8.3	14.2	10.9	8.0
2013	8.5	14.3	11.7	8.2
2014	8.2	14.4	12.6	8.4
2015	8.5	14.5	13.5	8.5
2016	8.1	14.5	14.4	8.7
2017	8.1	14.6	15.3	8.9
2018		14.6	15.3	8.9
2019		14.6	15.3	8.9

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Table 5: Current and proposed nitrogen excretion values (kg N/goat/year)

Year	Current value	Proposed values Dairy	Meat	Fibre
1990	10.6	20.1	10.4	10.4
1991	10.7	20.2	10.4	10.4
1992	10.8	20.3	10.4	10.4
1993	10.9	20.4	10.4	10.4
1994	11.0	20.5	10.4	10.4
1995	10.9	20.6	10.4	10.4
1996	11.2	20.7	10.4	10.4
1997	11.1	20.8	10.4	10.4
1998	11.1	20.9	10.4	10.4
1999	11.3	21.0	10.4	10.4
2000	11.3	21.1	10.4	10.4
2001	11.4	21.2	10.4	10.4
2002	11.4	21.3	10.4	10.4
2003	11.3	21.4	10.4	10.4
2004	11.5	21.4	10.4	10.4
2005	11.5	21.5	10.4	10.4
2006	11.5	21.6	10.4	10.4
2007	11.7	21.7	10.4	10.4
2008	11.9	21.8	10.4	10.4
2009	12.1	21.9	11.5	10.6
2010	11.8	22.0	12.7	10.8
2011	12.0	22.1	13.8	11.0
2012	11.9	22.2	15.0	11.2
2013	12.0	22.3	16.1	11.3
2014	11.7	22.4	17.3	11.5
2015	12.1	22.5	18.4	11.7
2016	11.5	22.6	19.6	11.9
2017	11.6	22.7	20.7	12.1
2018		22.7	20.7	12.1
2019		22.7	20.7	12.1

Table 6: Proposed faecal dry matter production values (kg/goat/year)

Year	Current value (NA, not used in current methodology)	Proposed values		
		Dairy	Meat	Fibre
1990		135	71	71
1991		136	71	71
1992		137	71	71
1993		137	71	71
1994		138	71	71
1995		139	71	71
1996		140	71	71
1997		140	71	71
1998		141	71	71
1999		142	71	71
2000		143	71	71
2001		144	71	71
2002		144	71	71
2003		145	71	71
2004		146	71	71
2005		147	71	71
2006		147	71	71
2007		148	71	71
2008		149	71	71
2009		150	86	78
2010		151	101	85
2011		151	117	92
2012		152	132	99
2013		153	147	105
2014		154	162	112
2015		154	178	119
2016		155	193	126
2017		156	208	133
2018		156	208	133
2019		156	208	133

Figure 2. Pathway for nitrous oxide emissions from dairy goat excreta. From Burggraaf et al (2019),