Revision of Emission Factor for Broilers

Current Position

The IPPC emission factor for broilers (and turkeys) is based on the NAEI (2006) emission factor of 62 gN/lu/d (This has increased slightly to 64 gN/lu/d in 2007). This is converted to IPPC units of kg/NH_3/animal place/yr by multiplying by the number of days in a year, converting units of nitrogen to ammonia and from livestock units to bird weight (365×(17/14)×(0.9/500)/1000). However, the operational practice of broiler units includes periods of house occupancy, delittering and disinfection.. Ammonia emission only occurs during the period of occupancy and delittering. The sheds are empty and not emitting ammonia during the disinfection period. The studies used to derive the emission factors often only measure emissions over the period of occupancy (although Demmers et al does include estimates for both occupancy and delittering).

The NAEI effectively takes the ammonia released from these activities and 'smooths' the release over the year, calculating an emission factor per day based on 365 days. This gives a notional daily emission which may be different to the actual day rate during the period of occupancy.

Whilst this may be appropriate for inventory purposes, it is not correct if the effect of changes to the period of occupancy on emission factors are being considered. A better approach is to estimate the emission rate per day of occupancy, multiply this up by the period of occupancy and then add any further emission due to delittering.

Industry Operational Data

The British Poultry Council on behalf of the Environment Agency collected information on operational practice across the Broiler industry. The results are summarised in Table 1 below.

Table 1 UK Broiler Operational data

Operational parameter	NAEI (2006)	Industry survey (Weighted average by bird No.)
Period of occupancy (days/yr)	-	278
Delittering: period litter is left in the house after depletion (days/yr)	-	7
Average bird weight (kg)	0.9	1.0

ADAS report on Emissions from UK Broiler Housing

The British Poultry Council and National Farmers Union commissioned ADAS (ADAS 2008) to produce a report reviewing the ammonia emission factors for broiler housing. The report reviewed the papers used as the basis for the NAEI emission estimates and identified three key papers (Demmers et al (1999), Robertson et al (2002) and Nicholson et al (2004)). Papers by Peirson (1995) and Frost et al (2002) were not included as Peirson (1995) refers to turkeys and Frost et al (2002) is a duplication of the value reported by Robertson et al (2002).

The approach taken by ADAS was to use the daily emission factor from the NAEI multiplied by a housing period (277 days) to give an annual emission. However, as indicated above, the NAEI daily emission factor is not a true day rate, rather it assumes the actual emission from the housing period is smoothed over 365 days. The ADAS paper also uses the NAEI average weight for a bird of 0.9kg, rather than the newer value derived from the British Poultry Council data of 1.0 kg.

Assessment of revised emission factor

Emission factors for the period of housing occupancy have been extracted from the three key papers above (Demmers et al (1999), Robertson et al (2002) and Nicholson et al (2004)). These have then been corrected as necessary for differences in reporting of nitrogen or ammonia and industry average weight to give an emission factor per day of occupancy. This can then be multiplied up by the number of occupancy days to give an annual emission per unit of live weight due to occupancy only. The IPPC emission factor was then calculated by dividing the average weight per bird (1.0kg) by the unit livestock weight (500kg) and multiplying by the annual emission from occupancy only.

In reviewing the papers it was noted that Nicholson et al. reported values for both bell and nipple drinkers. The NAEI emission factor uses the average of these values. For this assessment the emission factor for nipple drinkers only has been used as this is now industry practice.

Table 2 Comparison of emission factors for occupancy only from ADAS (2008) and EA calculation based on industry operational data[1]

Study	ADAS Study: Emission Factor		EA estimate: Emission factor	
	gNH_3-N/lu/d	$kgNH_3$/bird place/year	gNH_3-N/lu/d occupancy	$kgNH_3$/bird place/year
Demmers et al (1999)	79	0.048	91	0.061
Robertson et al (2002)	44	0.027	40	0.027
Nicholson et	36	0.022	32	0.022

[1] Based on industry operational data (278 days occupancy, 1.0kg average weight per bird)

Study	ADAS Study: Emission Factor		EA estimate: Emission factor	
	gNH_3-N/lu/d	$kgNH_3$/bird place/year	gNH_3-N/lu/d occupancy	$kgNH_3$/bird place/year
al (2004). Expt 1a				
Nicholson et al (2004). Expt 1b	67	0.041	60	0.041
Nicholson et al (2004). Expt 2	53	0.032	24	0.016
Mean	56	0.034	49	0.033

Ammonia release from delittering

Only the paper by Demmers et al (1999) reports ammonia emissions separately for occupancy only and delittering. The paper by Robertson et al (2002) is unclear on this but personal communication from ADAS indicates that emissions from delittering were not included in the reported release rates.

Demmers et al (1999) suggest that delittering leads to an increase of ammonia emission from16.6 $kgNH_3$/lu/yr for occupancy only, to 18.6 $kgNH_3$/lu/yr including delittering. However, they do not give an estimate of the total number of days in the year when litter is left in the otherwise empty house. Consequently, an estimate of ammonia released during delittering needs to be based on the information provided on the individual crop cycle studied.

Fig 7. of Demmers et al (1999) indicates that ammonia losses in the period between the end of the crop and removal of the litter occurred over a 4 day period. By interpolation from the graph the ammonia released during this period was 405 gNH_3/lu/4days (101 gNH_3/lu/d). Industry data suggests that there are seven days per year when litter remains in the house following depletion. This gives emission factors of 0.203 gNH_3/place/day litter left in house, equivalent to 1.4 gNH_3/place/yr.

Conclusion

It is suggested that the annual emission rate for broilers should be amended to 0.034 $kgNH_3$/place/year based on 278 days occupancy + 7 day delittering. (33 gNH_3/place/year occupancy + 1.4 gNH_3/place/year delittering)

Where variable occupancy or delittering periods are being considered then an emission factor of 0.119 gNH_3/place/day of occupancy (excluding delittering) should be applied. Emissions from delittering are equivalent to 0.203 gNH_3/place/day litter remains in the house following depletion.

Appendix 1 shows example annual emission calculations for two different operational scenarios

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Revision to delittering calculation 20 February 2009. Example inserted and minor edits.

Further revision to delittering calculation 06 March 2009.

References

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Appendix 1 Example calculations of annual ammonia emissions.

1) Farm with 400 000 birds operating on 278 days occupancy per year and with a total of 7 days during the year when litter is left in the house following depletion**.**

Annual emission due to occupancy = 278 d × 0.119 gNH_3/place/day × 400 000 birds = 13233 kg NH_3 per year due to occupancy.

Annual emission due to delittering period = 7d × 0.203 gNH_3/place/day × 400 000 birds = 568 kg NH_3 per year arising from the delittering period.

Total annual emission = 13233 kg NH_3 per year due to occupancy + 568 kg NH_3 per year arising from the delittering period = 13801 kg NH_3 per year.

2) Farm with 400 000 birds operating on 260 days occupancy per year and with a total of 2 days during the year when litter is left in the house following depletion**.**

Annual emission due to occupancy = 260 d × 0.119 gNH_3/place/day × 400 000 birds = 12376 kg NH_3 per year due to occupancy.

Annual emission due to delittering period = 2d × 0.203 gNH_3/place/day × 400 000 birds = 162 kg NH_3 per year arising from the delittering period.

Total annual emission = 12376 kg NH_3 per year due to occupancy + 162 kg NH_3 per year arising from the delittering period = 12538 kg NH_3 per year.