SNAP CODES:	**100501**	**100508**
	100502	**100509**
	100503	**100510**
	100504	**100511**
	100505	**100512**
	100506	**100513**
	100507	**100514**
		100515
SOURCE ACTIVITY TITLES:	**MANURE MANAGEMENT REGARDING ORGANIC COMPOUNDS**	
	Dairy cows	***Broilers***
	Other cattle	***Other poultry***
	Fattening pigs	***Goats***
	Sows	***Fur animals***
	Sheep	***Mules and Asses***
	Horses	***Camels***
	Laying hens	***Buffalos***
		Other animals
NOSE CODE:	**110.05.01**	**110.05.08**
	110.05.02	**110.05.09**
	110.05.03	**110.05.10**
	110.05.04	**110.05.11**
	110.05.05	**110.05.12**
	110.05.16	**110.05.13**
	110.05.07	**110.05.14**
		110.05.15
NFR CODE:	**4B1a**	**4B9**
	4B1b	**4B9**
	4B8	**4B4**
	4B8	**4B13**
	4B3	**4B7**
	4B6	**4B5**
	4B9	**4B2**
		4B13

1 ACTIVITIES INCLUDED

VOCs comprise both methane (CH_4) and non-methane volatile organic compounds (NMVOCs). NMVOCs are defined as “all those artificial organic compounds different from methane which can produce photochemical oxidants by reaction with nitrogen oxides in the presence of sunlight”.

Methane emissions from enteric fermentation and animal waste management are considered in SNAP code 100400; emissions from unfertilized agricultural land and land fertilized with N-containing fertilizer are considered under SNAP codes 100200 and 100100 respectively.

This chapter considers the emission of methane and non-methane volatile organic compounds (NMVOCs) from the excreta of agricultural animals deposited in buildings and collected as either liquid slurry or solid manure, including emissions from animal excreta at all stages: animal housing, manure storage and from land spreading of manures. Emissions from excreta deposited in fields by grazing animals should be dealt with under SNAP codes 100100 (Cultures with fertilizers) and 100200 (Cultures without fertilizers) in this Guidebook. However, no NMVOC emission factors are available there.

2 CONTRIBUTIONS TO TOTAL EMISSIONS

2.1 Methane

Each microbial fermentation of digestible organic matter under anaerobic conditions results in methane formation. In agriculture, these conditions are met in the animal digestive systems and during the storage of animal wastes. Overall, agriculture's contribution adds up to nearly 50 % of the total (EU15 for 1999, EEA 2001). Animal husbandry is the major agricultural source (96 % of the agriculture total).

2.2 Non-methane volatile organic compounds

In the CORINAIR90 inventory (29 countries), emissions of NMVOCs from agriculture account for only 2% of total NMVOC emissions; the greatest proportion (98%) is emitted by other activities.

The contribution to total NMVOC emissions from cultures with and without fertilizers and from stubble burning is very low (0.2 % for both) and almost nil from enteric fermentation. Emission estimates for manure management account for 1.6 % (with 1.4 % for pigs) but even this value is not of great significance.

The estimates of the NMVOC emission for each European Country show a wide variations in the percentage of VOC emissions attributed to agriculture.

3 GENERAL

3.1 Description

3.1.1 Methane

Methane is produced from the decomposition of organic components in animal waste. The amount of released methane depends on the quantity of waste produced and the portion of the waste that decomposes anaerobically. When the animal waste is stored or treated as a liquid (as in lagoons and pits) it tends to decompose anaerobically and methane can be produced. When the waste is handled as a solid (as in stacked piles) or when it is deposited on pastures, it tends to decompose aerobically and little or no methane is produced.

3.1.2 Non-methane volatile organic compounds

A list of the principal NMVOCs, from the main emission sources, and a classification of the VOCs according to their importance, is included in the protocol regarding the fight against emissions of volatile organic compounds and their transnational flows, drafted in Geneva on 18/11/1991 during the congress on Long-Distance Transnational Atmospheric Pollution of 1979.

The protocol classifies NMVOCs into three groups, according to their importance in the formation of ozone episodes. Both the global quantity emitted and the VOCs reactivity with OH-radicals are considered.

There is very little information about NMVOCs emissions from animal manure which can be used to make quantitative estimates and identification of emission factors. However, because NMVOCs are responsible for odour emissions and nuisance, both the compounds in the air of livestock buildings and in manure and the techniques to measure the odour emissions have been investigated.

An exhaustive list of organic compounds identified in livestock buildings was compiled by O'Neill and Phillips (1992) on the basis of a literature review. The compounds most frequently reported in these investigations, which are heavily biased towards piggeries, are *p*-cresol, volatile fatty acids and phenol. Concentrations of these compounds in the atmosphere display wide variations; e.g. the concentration of *p*-cresol varies from $4.6 \cdot 10^{-6}$ to 0.04 mg m^{-3} and of phenol from $2.5 \cdot 10^{-6}$ to 0.001 mg m^{-3}.

An attempt to estimate quantitative gas emissions from pig housing in former West Germany has been done by Hartung and Phillips (1994) based on concentration data for 23 trace gases measured in piggeries. Fatty acids (acetic, propionic, *i*- and *n*-butyric, *i*- and *n*-valeric, *i*- and *n*-hexanoic, heptanoic, octanoic and pelargonic acids), phenols and indoles (phenol, *p*-cresol, indole, skatole), methylamines and other gases as acetone were measured, assuming an average ventilation rate of 150 m^3 LU^{-1} h^{-1}.

3.2 Controls

3.2.1 Methane

There are two strategies to decrease the methane emissions from animal wastes: Firstly, the formation of methane is reduced by frequently removing settled sludge and solid material from the manure storage. This results in a low density of methane producing bacteria in the storage. Secondly, methane emissions increase by creating favourable conditions for the methane producing bacteria in a bio-gas plant. The produced bio-gas has to be collected and can be used for different purposes (heating, producing electricity). There is very little emission of methane to the atmosphere.

3.2.2 Non-methane volatile organic compounds

Techniques which reduce ammonia and odour emissions can also be considered effective in reducing the emission of NMVOCs from animal manure. Hence, in order to reduce emissions from livestock buildings, techniques mentioned for ammonia (SNAP code 100900) can be applied (e.g. immediate removal of urine from cubicles for cattle, fast removal of slurry for pigs and belt drying of manure inside the poultry houses for laying hens). Other techniques which result in a reduction of the emission of NMVOCs are covering the slurry storage outside the building, and collecting and burning the bio-gas generated. The latter is the most effective way, however, systems already described for reducing ammonia emissions from storage such as natural and artificial floating crust and floating mats may give some odour reduction due to reduction of the emission of VOCs (Mannebeck, 1986). Injection of slurry is an effective way to reduce emission of NMVOCs during spreading. Odour emission reduction by these methods has been measured, but these data are not directly applicable to NMVOCs.

4 SIMPLER METHODOLOGY

4.1 Methane

The simpler approach for estimating methane emission from animal husbandry is to use an average emission factor per animal for each class of animal and to multiply this factor with the number of animals counted in the annual agricultural census. For enteric fermentation and for animal waste management Table 2 of SNAP 100400 presents the recommended IPCC methane emission factors for the different classes of animals (IPCC, 1997, 2000).

4.2 Non-methane volatile organic compounds

Compared to the total emission of NMVOCs from other sectors, the contribution from agriculture (animal manure) seems to be negligible. At present, data of NMVOC emission from animal manure (livestock buildings, storage and spreading) do not allow to estimate any average emission factors for these compounds. Experimental work on direct measurements to estimate NMVOC emission factors is definitely needed.

5 DETAILED METHODOLOGY

In their Tier 2 approach, IPCC (1997, 2000) also provide a detailed methodology for the calculation of methane emissions from manure management as a function of animal performance and the frequency distribution of animal waste storage facilities.

Calculations describing the amount of volatile solids (i.e. the amount of degradable organic material in livestock manure) have to fit the respective amounts of digestible energy needed for calculations made under SNAP code 100500. The frequency distributions of manure management systems has to coincide with the data used within SNAP code 100900.

6 RELEVANT ACTIVITY STATISTICS

For the simpler methodology, data is required on animal numbers for each of the categories listed in SNAP code 100400, Table 2. The annual agricultural census can supply these data. Otherwise the statistical information from Eurostat can be used or the FAO Production Yearbook.

For the detailed methodology, the data is required on animal numbers of the relevant sub-categories as well as matching data sets describing the excretion of volatile solids as a function of animal performance and feed, as well as the frequency distribution of the respective manure management systems.

Once emissions have been calculated at whatever is determined by the national experts to be the most appropriate level of detail, results should also be aggregated up to the minimum standard level of information as given in SNAP 100400, Table 3. This will allow for comparability of results among all participating countries. The data and assumptions used for finer levels of detail should be reported to ensure transparency and replicability of results among all participating countries.

7 POINT SOURCE CRITERIA

Emission from this sub-sector should be considered as area sources.

8 EMISSION FACTORS, QUALITY CODES AND REFERENCES

9 SPECIES PROFILES

10 UNCERTAINTY ESTIMATES

Uncertainties in methane emission factors are in the magnitude of 30%.

Uncertainties in animal numbers per class of animals are in the magnitude of 10%.

11 WEAKEST ASPECTS/PRIORITY AREAS FOR IMPROVEMENT IN CURRENT METHODOLOGY

Lack of measurements of VOC emissions from manure management is a major weakness.

12 SPATIAL DISSAGGREGATION CRITERIA FOR AREA SOURCES

The detailed methodology will provide spatially resolved emission data for methane on the scale for which matching activity data and frequency distributions of storage systems and grazing times are available.

13 TEMPORAL DISAGGREGATION CRITERIA

14 ADDITIONAL COMMENTS

15 SUPPLEMENTARY DOCUMENTS

No supplementary documents are needed to calculate national methane emissions, as outlined for the simpler methodology. The scientific basis of the emission factors is described in detail in IPCC (1997, 2000).

16 VERIFICATION PROCEDURES

17 REFERENCES

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18 BIBLIOGRAPHY

19 RELEASE VERSION, DATE AND SOURCE

Version:	1.3
Date:	November 2002
Updated by:	Ulrich Dämmgen Federal Agricultural Research Centre, Institute of Agroecology, Germany
Contribution from:	This chapter originally formed parts of chapters 1040 "Enteric fermentation" and 1050 "Manure Management Regarding Organic Compounds" including both carbon and nitrogen compounds, from which it was extracted.
Original authors:	Klaas Van Der Hoek, RIVM, The Netherlands Sue Couling, Silsoe Research Institute, UK

20 POINT OF ENQUIRY

Any comments on this chapter or enquiries should be directed to:

Ulrich Dämmgen

Institut für Agrarökologie
Bundesforschungsanstalt für Landwirtschaft
Bundesallee 50
38116 Braunschweig
Germany

Tel: +49 531 596 2601
Fax: +49 531 596 2599
Email: ulrich.daemmgen@fal.de