

## Supporting document on determination of emissions from pig and poultry farms

### SUMMARY

This paper summarises the data and emission methods used for estimating the returns from agriculture during the first EPER return. In virtually all cases the emissions have been estimated for individual facilities using emission factors that are multiplied by the weight or number of animals to obtain an emission value. This paper compares the different methods that have been used to estimate these values and makes some recommendations for a proposed way forward.

In the annex the Chairman of the Agriculture and Nature Panel of the UNECE Task Force on Emission Inventories and Projections, Ulrich Daemmgen, gives some further guidance for the implementation of the recommendations made.

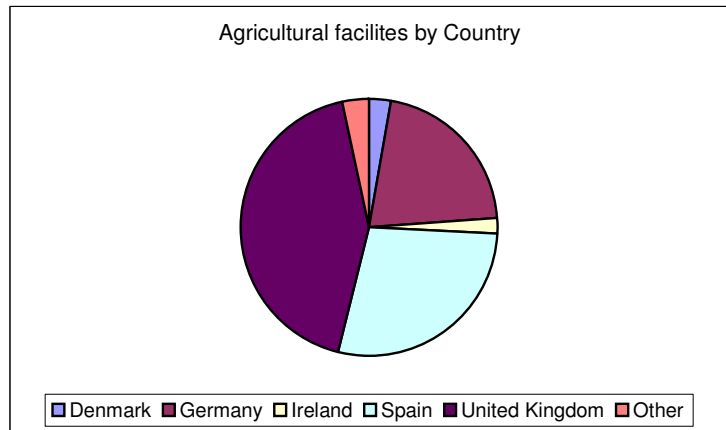
### 1. INTRODUCTION

The EPER Decision (2000/479/EC) requires member states to provide their emissions from all Annex 1 activities as defined under the IPPC Directive (Council Directive 96/61/EC). The first return was required by the end of September 2003<sup>1</sup> and was to include all Annex 1 activities that broke the relevant thresholds for reporting. A summary of the EPER data set for agriculture is provided below.

#### 1.1 EPER data provided for 2001 return

Table 1.1 – Number of agricultural facilities by country

Country	No. of facilities
Austria	1
Belgium	0
Denmark	74
Finland	3
France	3
Germany	593
Greece	0
Hungary	1
Ireland	54
Italy	12
Luxembourg	0
Netherlands	0
Norway	0
Portugal	39
Spain	775
Sweden	30
United Kingdom	1192



There are a large number of countries that provided no return (or only a few returns) for agricultural facilities in the first EPER data and whilst it is not the primary purpose of this paper to explore the reasons for this the key difficulties may be:

- Identifying individual facilities prior to end of permitting timetable ( including locations and “capacity”);
- Obtaining facility specific activity data and confidentiality of this data even where it is available; and

<sup>1</sup> In EPER decision the date was June 2003 but this date was extended to the end of September 2003

- Reconciling this “facility” data with more aggregated national emission datasets (e.g. CLRTAP returns for NH<sub>3</sub>).

Table 1.2 Emissions from agricultural facilities by country to Air (total in kg)

Country	Methane	Dinitrogen Oxide	Ammonia	PM10
Austria	0	0	19000	0
Denmark	0	0	1341200	0
Finland	0	0	36200	0
Germany	182000	515000	18599200	0
Ireland	0	0	15611000	0
Italy	0	0	217600	0
Portugal	0	12000	394300	0
Spain	1525000	669200	19887100	0
Sweden	0	0	520500	0
United Kingdom	52252000	0	44099500	327400

Key points to note:

- All countries provides estimations of ammonia (NH<sub>3</sub>) to air
- Germany, Portugal and Spain estimated emissions of Dinitrogen oxide (N<sub>2</sub>O)
- Germany, Spain and the UK estimated emissions of Methane (CH<sub>4</sub>)
- UK estimated emissions of PM10

Table 1.3 Emissions from agricultural facilities by country to Water and Sewer (total in kg)

Country	Direct to water (kg)					Indirect to water (kg)
	Nitrogen	Phosphorus	Cadmium and its compounds	Copper and its compounds	Zinc and its compounds	Phosphorus
France	0	0	0	0	0	46900
Hungary	118000	37000	0	0	0	0
Italy	50500	0	0	0	0	0
Portugal	75800	0	0	15431.1	10552	0
Spain		12200	774	0	0	0

Key points to note:

- Hungary, Italy and Portugal reported emissions of nitrogen to water
- Hungary, France and Spain reported emissions of phosphorus to water or sewer
- Portugal reported emissions of Copper and Zinc
- Spain reported emissions of Cadmium

The methodologies used to estimate these emissions are examined in Chapter 2.

## 2. EMISSION FACTORS USED FOR EPER RETURNS

The emission factors that are summarized below are all taken from individual methodologies submitted by individual countries, these methodologies are provided separately to this report.

### 2.1 Emission factors – Austria

The paper submitted by Austria shows the UNFCCC methodology for their national inventory. This uses the same methods as set out in the Joint CORINAIR/EMEP Atmospheric Emission Inventory Guidebook.

## 2.2 Emission Factors – Belgium

A national model developed by the University of Gent is used. This model is developed especially for the Flemish agriculture. It calculates the ammonia emissions based on the N-balance (N-excretion) for each stage in the manure cycle (stable/indoor manure storage, outdoor manure storage, spreading manure and emissions on the pasture), for the different animal species (cows, pigs, chickens and other cattle) and for the 308 different municipalities in Flanders. Further detail is provided in the Belgium document provided separately.

## 2.3 Emission Factors – Denmark

Table 2.3.1 Ammonia emission factors for Pig and Poultry in Denmark

Pigs		Poultry	
Livestock buildings with:	kg N per livestock unit (LU)	Livestock buildings with	kg N per livestock unit (LU)
Slurry	18 kg N	Deep litter (Broilers)	47 kg N
Solid manure + urine	29 kg N	Deep litter + solid manure (hens)	58 kg N
Slurry + deep litter	20 kg N	Solid manure (hens)	18 kg N
Deep litter	31 kg N	Slurry (hens)	13 kg N

- The emission of NH<sub>3</sub> is the emission of N \* 18/15. The estimates are based on standard figures estimated by DJF (Danish Institute of Agricultural Sciences) in 2000.
- A livestock unit (LU) is determined on basis of the manure production. 1 livestock Unit equals app. 100 kg N ex storage and is defined in Annex 1 in the Statutory order from the ministry of the environment no. 604 of July 15, 2002, on professional livestock, livestock manure, silage etc. (<http://www.skovognatur.dk/landbrug/hgb/engelskudgavehgb.pdf>)

## 2.4 Emission Factors – France

Table 2.4.1 Ammonia emission factors for Pigs in France

	Sows and boars	Post-weaning pigs	Fattening pigs (>30kg)	Total
<i>Emission factor (kg NH<sub>3</sub> per year)</i>	11.6	1.8	6.8	
<b>Number of places in facility</b>	N <sub>1</sub>	N <sub>2</sub>	N <sub>3</sub>	
<b>Level of activity</b>	L <sub>1</sub>	L <sub>2</sub>	L <sub>3</sub>	
<b>Emissions of NH<sub>3</sub> from facility</b>	11.6 x N <sub>1</sub> x L <sub>1</sub>	1.8 x N <sub>2</sub> x L <sub>2</sub>	6.8 x N <sub>3</sub> x L <sub>3</sub>	T1 = [11.6 x N <sub>1</sub> x L <sub>1</sub> ] + [1.8 x N <sub>2</sub> x L <sub>2</sub> ] + [6.8 x N <sub>3</sub> x L <sub>3</sub> ]
<b>Reduction for 2 phase feeding regime</b>				-17% R <sub>1</sub> =(T x 0.17)
<b>Preliminary total</b>				T2=T1-R <sub>1</sub>

### Notes:

**Emission factor:** If the post-weaning and fattening pigs are reared in the same building, combine the columns and emission factors, to give a new factor of 5.2kg ammonia per year.

**Level of activity:** Level of activity is 1, if the facility has functioned normally all year. Otherwise the level of activity is determined by (number of days the facility functioned/365)

Table 2.4.2 Additional calculations for ammonia determination

Additional reductions	Level of reduction	Component of ammonia release affected	Reduction to incorporate
<b>Reduction for Air scrubbing of building</b>			
For fattening pigs only	-23%	C1	$R_2 = (0.23 \times C1)T2$
For entire facility, including fattening pigs	-40%	C2	$R_3 = (0.40 \times C2)T2$
<b>Covering of effluent pits</b>	-6%	C3	$R_4 = (0.06 \times C3)T3$
<b>Spreading of liquid manure</b>	-23%	C4	$R_5 = (0.23 \times C4)T4$
<b>Manure treatment centre</b>	-33%	C5	$R_6 = (0.33 \times C5)T5$
<b>Extra one-off reductions</b>	Defined as appropriate	C6	$R_7 = (? \times C6)T6$
<i>Total additional deductions</i>			$R_2 + R_3 + R_4 + R_5 + R_6 + R_7$

<b>Total annual emission</b>	<b><math>T3 = T2 - (R_2 + R_3 + R_4 + R_5 + R_6 + R_7)</math></b>
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Table 2.4.3 Ammonia emission factors for Poultry in France

	Kg of NH <sub>3</sub> /m <sup>2</sup> of facility	Kg of NH <sub>3</sub> /place
Chickens, turkey, guinea-fowl,	2.9	
Chicks	1.7	
Ducks for roasting	4.6	
Laying hens		0.3
Laying hens (with drying of manure)		0.15
Laying hens (with deep manure pits)		0.45

Table 2.4.4 Additional calculations to apply to ammonia estimations

Treatment	Percentage change to emissions
On-site composting of manure	+25%
Transfer to a manure transformation unit	-10%
Covering of manure pits	-6%
Manure spreading or turning within 12 hours	-23%
Treatment station for liquid manure	-33%

## 2.5 Emission Factors – Finland

Table 2.5 Ammonia emission factors for Pig and Poultry in Finland

Emission factors for manure management used in Finland	
Type of animal	kg NH <sub>3</sub> / animal
Fattening pigs	4.2
Sows	14.9
Laying hen (laying hens and parents)	0.34
Broiler	0.055

Source: Grönroos, J., Nikander, A., Syri, S., Rekolainen, S. and Ekqvist, M. (1998) Agricultural ammonia emissions in Finland. Finnish Environment Institute. Helsinki: The Finnish Environment 206. 65 p. (In Finnish)

## 2.6 Emission Factors – Germany

Table 2.6.1 Emission Factors for Pig and Poultry in Germany

Type of Storage for Liquid manure	Emitting part of facility	Emission Factors (kg/yr/tonne animal weight)			
		Poultry		Pigs	
		NH <sub>3</sub>	N <sub>2</sub> O	NH <sub>3</sub>	N <sub>2</sub> O
Storage in livestock building	Livestock building	120	10	60	8
Separate manure Storage (outside of livestock building)	Livestock building	60	5	30	4
	Without covering	60	5	30	4
	With covering	6	0.5	3	0.4

Table 2.6.2 Alternative Ammonia Emission Factors for Farming or Breeding of Livestock

Species, Production Specialisation, Livestock Housing, Manure Storing	Ammonia Emission Factor (kg/(animal place a))
<b>Fattening Pigs</b>	
Compulsory ventilation, liquid manure system (partially or fully slated floors)	3.64
Compulsory ventilation, solid manure system	4.86
Naturally ventilated housing, kennel housing (liquid or solid manure system)	2.43
Naturally ventilated housing, deep litter or composting system	4.86
<b>Swine nursery</b>	
(breeding sow management) All areas and types of livestock housing (breeding sows incl. Piglets up to 25 kg)	7.29
<b>Laying hens</b>	
Cage rearing using ventilated dropping belts	0.0389
Aviary housing using ventilated dropping belts	0.0911
Floor management / free – range (manure removal 1 time per turn)	0.3157
<b>Feeding poultry</b>	
Fryers, floor management	0.0486
Ducks	0.1457
Turkeys	0.7286

## 2.7 Emission Factors – Ireland

Table 2.7.1 Emission Factors for pigs in Ireland

Pig type	NH <sub>3</sub> emission (kg/hd/year)	N <sub>2</sub> O emission (kg/hd/year)	CH <sub>4</sub> emissions (kg/hd/year)
Sows(Farrowing)	5.2	0.367	1.5
Sows(Dry)	3	0.367	1.5
Gilts	4.56	0.367	1.5
Boars	3.5	0.367	1.5
Weaners	0.36	0.367	1.5
Fatteners	4.56	0.367	1.5

## 2.8 Emission Factors - Portugal

Table 2.8.1 Emission Factors from Pigs to Air in Portugal

	NH <sub>3</sub>	CH <sub>4</sub>	N <sub>2</sub> O	PM10
Manure management – Fattening pigs	2.89 kg/animal (CORINAIR)	10 kg/animal (CORINAIR)	0.02 ton/500 animal units (AP42)	2.0 ton/500 animal units (AP42)
Manure management – Sows (includes piglets)	7.44 kg/animal (CORINAIR)	10 kg/animal (CORINAIR)	0.02 ton/500 animal units (AP42)	2.0 ton/500 animal units (AP42)

- CORINAIR
- (AP42, <http://www.epa.gov/ttn/chief/ap42/ch09/draft/draftanimalfeed.pdf>)
- An animal unit (as defined by US EPA) respects to the pollution potential of a cow of 543 kg (1000 lb). Using Portugese methodology 2 sows = 1 animal unit = 7fattening pigs

Table 2.8.2 Emission Factors from Pigs to Water in Portugal

	Nitrogen	Phosphorus	TOC	Cu	Zn
Emission Factor	0.018 kg/animal	0.006 kg/animal	0.09 kg/animal	60 mg/l 0.2628 kg/animal	15 mg/l 0.0657 kg/animal
Then Removal rate for treatment	60%	78%	84%	46%	58%

For Cu and Zn : Pollutant Emission (kg/year) = Pollutant Concentration (g/l) \* 12 (l/animal.day) \* 365 (day) \* Average Number (Av. N.) of Animals (Animal/year) \* 10<sup>-3</sup> (kg/g)

Table 2.8.3 Emission Factors from Poultry to Air in Portugal

	NH <sub>3</sub>	CH <sub>4</sub>	N <sub>2</sub> O	PM10
Manure management	0,15 kg/animal (CORINAIR)	0.117 kg/animal (CORINAIR)	1.5 ton/500 animal units (AP42)	2.1 ton/500 animal units (AP42)

An animal unit (as defined by US EPA) respects to the pollution potential of a cow of 543 kg (1000 lb).

## 2.9 Emission Factors – United Kingdom

Table 2.9.1 Activity Data Provided For Pigs

Numbers (ALL)
Places (calculated see Table 2 for some categories)

Table 2.9.2 Activity Conversion Tables For Pigs

Animal Type	From	To	Conversion Factor
Growers and Pigs >30 Kg	Numbers	Places	Divide by 2.6
Pigs<30 Kg	Numbers	Places	Divide by 5
Sucklers	Numbers	Places	Divide by 12

Table 2.9.3 Emission Factors For Pigs

Animal Type	Housing	Pollutant	E.F.	Units	Data Source
Boars		NH3 (except manure)	3.1	kg/place	DEFRA
Sows, Gilts		NH3 (except manure)	2.2	kg/place	DEFRA
Growers	straw	NH3 (except manure)	1.3	kg/place	DEFRA
Growers	fully slatted	NH3 (except manure)	1.4	kg/place	DEFRA
Fatteners	straw	NH3 (except manure)	3.3	kg/place	DEFRA
Fatteners	fully slatted	NH3 (except manure)	3.5	kg/place	DEFRA
Weaners	straw	NH3 (except manure)	0.6	kg/place	DEFRA
Weaners	fully slatted	NH3 (except manure)	0.2	kg/place	DEFRA
Farrowers	straw	NH3 (except manure)	3.9	kg/place	DEFRA
Farrowers	fully slatted	NH3 (except manure)	3.9	kg/place	DEFRA
Maidengilts	straw	NH3 (except manure)	1.2	kg/place	DEFRA
Maidengilts	fully slatted	NH3 (except manure)	2.2	kg/place	DEFRA
Sows, Gilts, Maidengilts		NH3 (Manure)	2.18	kg/animal	CORINAIR
Boars, Growers, Fatteners, Weaners, Farrowers		NH3 (Manure)	0.85	kg/animal	CORINAIR
All Pigs		CH4 (Enteric)	1.5	kg/head	IPCC p4.3 workbook2
All Pigs		CH4 (Manure)	3	kg/head	IPCC p4.3 workbook2

The Efs for weaners are used to calculate emissions in the 'pigs<30kg' category. The EFs for fatteners are used to calculate emissions in the 'pigs>30kg' category. The EFs for farrowers are used to calculate emissions in the 'sucklers' category.

Table 2.9.4 Activity data for poultry

Weight (ALL)
Places (calculated see Table 2.8.5)
Numbers (calculated see Table 2.8.5)

Table 2.9.5 Activity conversion

ANIMAL TYPE	From	To	Conversion Factor
Broilers (Breeders, Layers)	Weight	Numbers Places	Divide by 1.85 Divide by 11.1
Turkeys	Weight	Numbers Places	Divide by 11 Divide by 27.5
Ducks	Weight	Numbers Places	Divide by 2.3 Divide by 12.6
Geese	Places	Numbers	Multiply by 5
Game	Places	Numbers	Multiply by 6
Pullets	Places	Numbers	Multiply by 2.6

Table 2.9.6 Emission factors for poultry

Animal Type	Pollutant	E.F.	Units	Data Source
Broilers, Ducks, Layers (cages – belt), Pullets	NH3 (except manure)	0.1	Place	DEFRA
Layers	NH3 (except manure)	0.2	Place	DEFRA
Turkey	NH3 (except manure)	0.3	Place	DEFRA
Geese, Game	NH3 (except manure)	0.48	Numbers	CORINAIR
Broilers	NH3 (Manure)	0.02	Numbers	CORINAIR
Layers, Pullets	NH3 (Manure)	0.03	Numbers	CORINAIR
Turkeys, Geese, Game, Ducks	NH3 (Manure)	0.06	Numbers	CORINAIR
Broilers, Ducks	PM10	0.00466	Numbers	DEFRA
Broilers	PM10	0.0098	Numbers	DEFRA
Layers	PM10	0.00229	Numbers	DEFRA
Turkeys	PM10	0.03922	Numbers	DEFRA
Broilers, Ducks, Layers, Turkeys	CH4	0.117	Numbers	CORINAIR

Corinair numbers were taken from the Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook see Table 4.1, Chapter Manure Management regarding organic compounds and for methane from table 2, Chapter Enteric Fermentation

### 3. SUMMARY AND RECOMMENDATIONS

There are a number of separate issues that emerge from the current estimation of agricultural facilities for EPER and these are bulleted below.

- Many countries were unable or did not provide any emissions from agricultural facilities for the first EPER return.
- There is a wide variation in the range of substances that individual countries have chosen to estimate emissions for. The only consistent substance that was reported is Ammonia to air.
- Even where there is a commonality in the substance selected for estimation there are likely to be differences in the emission factors that have been chosen by each country.
- Emission factors that have been used include both those from international sources (Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook) and national sources of information.
- Many countries have linked the reporting techniques for agricultural facilities to existing Inventory methodologies that were developed for national and international reporting requirements (e.g. LRTAP). The primary source of estimation techniques from these sources is the Atmospheric Emission Inventory Guidebook and specifically the Agriculture Expert Panel to this guidebook.
- The techniques for estimation rarely take account of “different” environmental practice and so are unlikely to show improvements in environmental performance by individual facilities (An exception to this is the methodology employed by France).

Based on these findings we would recommend that:

- Whilst there may be good reasons for differences between each country (depending on climate, farming practice etc.) the current differences should be further investigated and where possible a common approach should be adopted.
- As a starting point the Agriculture Expert Panel should be approached to consider whether a more consistent methodology for emissions to Air (and water?) could be adopted without leading to less accurate data at a national level.
- The consideration of different “environmental practice” for these facilities is a worthwhile step and should be further investigated.

## Annex

### Remarks by Ulrich Daemmgen, Chairman of the Agriculture and Nature Panel of the UNECE Task Force on Emission Inventories and Projections<sup>2</sup>

The Supporting document on determination of emissions from pig and poultry farms recommends:

- Whilst there may be good reasons for differences between each country (depending on climate, farming practice etc.) the current differences should be further investigated and where possible a common approach should be adopted.
- As a starting point the Agriculture Expert Panel should be approached to consider whether a more consistent methodology for emissions to air (and water?) could be adopted without leading to less accurate data at a national level.
- The consideration of different “environmental practice” for these facilities is a worthwhile step and should be further investigated.

The chairman of the Agriculture and Nature Panel of the UNECE Task Force on Emission Inventories and Projections explains:

The methods proposed in the Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook<sup>3</sup> are constructed in a way that the emissions from single agricultural enterprises can be calculated adequately when the detailed methodology (see below) is used.

The methods provided comprise simpler methodologies which use emission factors (and partial emission factors for housing and storage) irrespective of countries and time. These are to be used, if no other data are available. The Guidebook also provides a set of detailed methodologies for the calculation of emissions from animal houses and storage using a more sophisticated calculation procedure (mass flow approach, see Guidebook chapter B1000, Introductory remarks) which presupposes existence of individual data for nitrogen excretion, the respective housing types and storage facilities. If a detailed methodology is used, partners have to document the data used in detail. This is in line with the general requirement that inventories have to be transparent, consistent, comparable, complete and accurate.

The use of this methodology is likely to result in data which are consistent and comparable with the data provided in national inventories. It avoids misunderstandings which originate in the use of different units (e.g. animals, animal numbers, livestock units) and nitrogen pools.

Guidebook chapters refer to the fact that technical help (spreadsheets) is available (at present from the chairman).

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<sup>3</sup> EMEP/CORINAIR (2002) Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook. 3rd edition, Copenhagen, <http://reports.eea.eu.int/EMEPCORINAIR3/en/page019.html>

A Guidebook chapter dealing with PM10 emissions from animal husbandry is being discussed at present and likely to be available 2005.