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Estimation of Danish emission factors for ammonia from field-applied liquid manure for 1980 to 2019

Advisory report from DCA – Danish Centre for Food and Agriculture

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Data sheet

Title:	Estimation of Danish emission factors for ammonia from field-applied liquid manure for 1980 to 2019
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Comments to the report:	As part of this assignment, new data sets have been collected and analyzed, and the report presents results, which – at the time of the publication of this present report – have not been published elsewhere. In case of subsequent publishing in journals with external peer review, changes may appear.
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Foreword

This report has been prepared according to a contract between the Ministry of Environment and Food and Aarhus University in relation to the project "Nye emissionsfaktorer fra udbragt gylle" signed in June 2020.

The project was initiated at the request of the National Emission Ceiling (NEC) expert committee, which was appointed by the ministry in January 2020 with the aim of investigating the possibilites of new initiatives that could reduce ammonia emission from agriculture. Committee members were from the Danish Agriculture & Food Council (two members), Danish Agro Industry (one member), the Danish society for Nature Conservation (one member), and Aarhus University (one member). The committee was chaired by the ministry.

Preliminary results of the project were presented on a web meeting on 21 August 2020 with the ministry.
Preliminary results from the ALFAM2 model (Ammonia Loss from Field-Applied Manure - https://projects.au.dk/alfam/) were shared in a draft report with the ministry following the above-mentioned meeting. However, these results had not been subjected to peer review prior to being shared with the ministry.
The present report will update the preliminary results used in the publications listed below.

The consequences of updated activity data and preliminary emission factors have been described in: https://dce.au.dk/fileadmin/dce.au.dk/Udgivelser/Notatet_2020/N2020_85.pdf
The authors included Tavs Nyord, Sasha D. Hafner and Sven Sommer, who contributed the text in section 3.2.

Following NEC committee meetings, the NEC committee requested a summary note on 7-8 different ammonia-reducing initiatives. This publication used the preliminary emission factors – https://dce.au.dk/fileadmin/dce.au.dk/Udgivelser/Notatet_2020/N2020_88.pdf

Senior Advisor Tavs Nyord left Aarhus University on 31 May 2021, whereafter Senior Researcher Anders Peter S. Adamsen took over the management of the project and oversaw completion of the report.

Table of contents

Abstract (English)

This document reviews the calculation of emission factors (EFs) for ammonia (NH_3) lost from field-applied liquid manure in Denmark and describes the development of new EFs. The original EFs were developed in 2008 (Hansen et al., 2008) using a combination of the ALFAM model presented in 2002 (Søgaard et al., 2002) and fixed emission reductions. The review shows that many more emission measurements are available since these EFs were last updated, and that some limitations of the original approach can now be addressed due to the availability of new measurements and a new model. New EFs were calculated using the semi-empirical ALFAM2 model, which represents physical controls on emission in a simplified manner, with parameter values based on measurements made in more than 600 field plots in several European countries. The EFs (provided in Appendix 1) reflect effects of manure composition (dry matter and pH for cattle and pig manure as well as digestate) and weather (air temperature and wind speed). Low-emission application methods (trailing hose, open and closed slot injection, and incorporation) and manure acidification (barn/storage and field) were also included. New EFs range from below 1% of applied total ammoniacal nitrogen (TAN) for a combination of acidification and incorporation, to above 50% for broadcast application during warm periods. New EFs are different from 2008 EFs, but not consistently lower or higher. Differences have multiple causes, including new measurements and a different (completely model-based) approach. New EFs are presented for four periods: 1980-1989, 1990-1999, 2000-2009, and 2010-2019. Changes over time were based on changes in climate and manure composition and are generally small. Much larger effects are seen in a switch from broadcast application to low-emission technologies. Significant sources of uncertainty in these new EFs include large variability among countries in emission measurements and related model parameter values, uncertainty in manure pH, and effects of rainfall. Regardless of uncertainties, results from emission experiments suggest that these new EFs are better supported by emission measurements and better reflect effects of manure characteristics, application methods, and weather than the 2008 EFs. We recommend replacing the 2008 EFs developed by Hansen et al. (2008) with the new EFs presented here for emissions inventory and related uses.

Sammendrag (Dansk)

I denne rapport præsenteres forudsætningerne for beregninger af ammoniak (NH3) emissionsfaktorer for gylle udbragt i Danmark. Emissionsfaktorerne er beregnet med ALFAM2 emissionsmodellen, der er en statistisk model, hvor fordampningen af NH3 beregnes ved brug af fysisk og kemiske parametre for processer og transport af NH3 fra den udbragte gylle til atmosfæren. Disse parametre er beregnet ved brug af data fra målinger af NH3 fordampningen fra ca. 600 forsøg i Europa.

Størrelsen af emissionsfaktorerne er påvirket af kategorien af gylle (kvæg-, svin- og afgasset gylle), gyllens sammensætning (tørstof og pH) og vejrforholdene (vindhastighed og lufttemperaturen). Der er beregnet emissionsfaktorer for lav-emissions udbringningsteknologier i form af udbringning med slæbeslange, nedfældning og nedmuldning, samt for forsuring af gylle foretaget i stalden, gylletanken eller under udbringning i marken.

De nye emissionsfaktorer varierer fra under 1% af den udbragte "total ammonium-kvælstof" (TAN = NH3-N + NH4+-N) for en kombination af forsuring og nedmuldning af gylle til næsten 50% for bredspredt gylle i perioder med høje lufttemperaturer. De nye emissionsfaktorer vil kunne erstatte emissionsfaktorerne, som blev beregnet i 2008 (Hansen et al., 2008). I det studie blev ALFAM modellen fra 2002 (Søgaard et al., 2002) anvendt til beregning af emissionsfaktorer for slæbeslangeudlagt gylle, og effekten af udbringningsteknik, separation, forsuring etc. blev beregnet på baggrunjd af data fra danske og udenlandske undersøgelser. De nye emissionsfaktorer er i flere tilfælde forskellige fra dem, der blev beregnet i 2008. Forskellen skyldes flere forhold, bl.a. er emissioner målt i studier siden 2002 lavere end målingerne fra studierne der blev benyttet i 2002, og der er indført en ny metode til beregning af emissionsfaktorer, hvor data vægtes således at effekten af forsøg med ekstreme resultater begrænses (begge forhold påvirker model-parameter-værdierne). I bilag til rapporten findes beregnede emissionsfaktorer for perioderne 1980-1989, 1990-1999, 2000-2009, and 2010-2019. Ændringer i klima og sammensætning af gylle har medført mindre forskelle i emissionsfaktorer over tid.

Væsentlige kilder til usikkerhed i disse nye emissionsfaktorer er stor variation i de målte emissioner målt i de lande, der har bidraget med data til ALFAM2 databasen, og usikkerhed i målinger af gyllens pH og af effekten af nedbør. Uanset usikkerhed i emissionsfaktorestimaterne i ALFAM2, antyder resultater fra test af emissionsfaktorerne mod resultater fra emissionsforsøg, at de nye emissionsfaktorer understøttes bedre af emissionsmålinger og afspejler bedre effekterne af gyllens fysisk/kemiske karakteristika, udbringningsmetoder og vejrfaktorerne end 2008-emissionsfaktorerne.

1 Introduction

Most ammonia (NH3) released into the atmosphere on a global and European scale is from agriculture, especially from animal husbandry (Behera et al., 2013). Atmospheric NH3 is a threat to human health, because it reacts with acidic compounds (Walker et al., 2006), forming fine particles that cause lung diseases (Wang et al., 2017). Ammonia deposited to land or waters may exceed the critical nitrogen (N) loads of natural ecosystems, leading to loss of function and diversity (Hertel et al., 2013; Sutton et al., 2011).

Concern over the harmful consequences of NH3 emission led to the adoption in 1999 of the Gothenburg Protocol of the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) (United Nations, 2019). The European Union has since enacted the National Emission Ceilings Directive (NECD) (European Parliament, 2016), which brings CLRTAP into the EU's legal framework, including the NH3 emission ceilings applied to the Member States.

Within Europe the highest NH3 emission rates (kg ha-1) occur in Denmark, Brittany, Belgium, the Netherlands, Northern Ireland, and the Po Valley (Backes et al., 2016). Most (> 95%) of the 63400 tonnes NH3-N emitted from Denmark originates from agriculture, and animal manure applied to fields account for ca. 28% of the total emission of NH3 based on earlier emission factors (Nielsen et al., 2020).

Both CLRTAP and NECD require that the EU countries submit an annual NH3 emission inventory. In the Danish inventories emission from field-applied manure is calculated using emission factors (EFs) that are a fraction of total ammoniacal nitrogen (TAN) applied in the field (Nielsen et al., 2020). The EFs currently in use were determined in 2008. In this document the calculation of these EFs are reviewed to answer the question of whether new values should be developed (Section 2) and alternative values are presented (Section 4).

2 Reasons for updating the emission factors

Earlier EFs were presented in Hansen et al. (2008). These values are related to application technique (broadcast, trailing hose, open slot injection, and closed slot injection), manure type (pig and cattle) and dry matter (DM), average monthly temperature and wind speed, as well as crop height (Hansen et al., 2008). These EFs were—in part—calculated using the ALFAM model, which was based on a database of European emission measurements (Søgaard et al., 2002). The ALFAM model provided plausible estimates of emission from manure applied by trailing hose, but other responses did not match expectations. Therefore, the model was used only to calculate EFs for trailing hose application, and other application methods, as well as some other effects, were included using fixed ratios with trailing hose emission. Reductions in emission related to crop height were included using the algorithm presented by Thorman et al. (2008). Emission following broadcast application was assumed to be 70% higher than trailing hose. Emission following open slot injection in grass was estimated as 75% of that from manure applied with trailing hose (25% reduction), or 55% for winter crops (45% reduction). Emission following closed slot injection to bare soil was estimated as 5% of the corresponding value for trailing hose (95% reduction). Incorporation of manure applied onto bare soil was accounted for by assuming the cumulative emission from surface applied manure with time after application could be computed using a Michaelis-Menten-type model, and that emission was reduced to 25% of untreated for the period after incorporation (Hansen et al., 2008). With respect to anaerobic digestion of manure in biogas reactors it was assumed that it has no influence on the EF, so emission from applied digestate from digestion of cattle or pig manure was assumed to be similar to the emission from untreated cattle or pig manure. Furthermore, the emission reduction for separation (application of liquid fraction) was set to 50%, and adding acid to pH around 6 at the time application was assumed to reduce NH3 emission to 33% of untreated manure (67% reduction) for the 2008 EFs.

Emission of NH3 from field-applied manure has been measured in many additional experiments since data were compiled for the ALFAM database and model. Many of these new data were combined with the original ALFAM measurements to create a publicly available database: the ALFAM2 database (Hafner et al., 2018) (available through https://www.alfam.dk). With the launch of the new database, the number of available observations to support model calibration (field plots with micrometeorological measurements) more than tripled (246 to 767). This expansion alone is sufficient reason to consider recalculation of EFs. But also, recent European emission measurements tend to be lower than earlier results (Sintermann et al., 2012; Haeni et al., 2016; Hafner et al., 2018). In the case of Switzerland, older measurements that show high emission have been found to be inaccurate (Haeni et al., 2016; Sintermann et al., 2012). Recent re-analysis of measurements made in The Netherlands concluded that early measurements were also overestimates, although the bias is small (around 10%) (Goedhart et al., 2020). Furthermore, relative reductions used for the earlier EFs are not supported by new measurements. For example, the 25% reduction for open slot injection used by Hansen et al. (2008) is smaller than the average in the ALFAM2 database (around 40%) (Hafner et al., 2018) and an earlier review (Webb et al., 2010) (around 75%), although variability in reported reductions is high (Webb et al., 2010; Hafner et al., 2018).

The ALFAM2 data were used to support development of a new NH3 emission model, referred to as the ALFAM2 model (Hafner et al., 2019). The model is semi-empirical (semi-mechanistic), and tracks the fate of applied TAN (kg ha−1) over time following a general concept presented by Chantigny (2004). The structure of the newer model is flexible and it can predict realistic emission responses to management (including incorporation at any time),

manure properties, and weather (including changes in weather during an emission event). These features represent improvements in relation to the original ALFAM model, which did not account for effects of management after application of manure or changes in weather following application (Søgaard et al. 2002). With its semi-mechanistic structure, the model presents an alternative to fixed relative reductions for estimating EFs from incorporation, injection, and acidification.

In some cases, assumptions made about slurry characteristics in 2008 are not valid. Digestate is the residue from anaerobic fermentation in biogas digesters, which are fed a mixture of livestock manure, organic waste, deep litter and plant biomass. Therefore, the assumption made in 2008 that digestion has no net effect is implausible.

Considering limitations in the approach used to calculated EFs in 2008 (Hansen et al., 2008), the availability of many new measurements and a new, more accurate, emission model, we conclude that new EFs should be developed, and this task was the focus of the present work. The objective of this work was to produce accurate and up-to-date EFs for Denmark that can be used to calculate national inventories of NH3 emission from field-applied manure for each decade since the 1980s. The remainder of this document describes the methods used for calculation of EFs (Section 3) and presents new EFs, including a comparison to those from 2008 (Section 4).

3 Methods

In this work, the ALFAM2 model was used to calculate EFs following the approach shown in Fig. 1. General "application conditions" for which EFs were required were provided by the Danish Centre for Environment and Energy at Aarhus University (DCE) (Rikke Albrektsen and Mette Hjorth Mikkelsen, personal communication). These conditions included timing (month or season), crop type (if any), manure type, application method, and whether and when manure was incorporated after application. Development of the application conditions are explained in detail in a recent report, and are not discussed further here (Nielsen et al., 2020). Quantitative manure properties and weather values were linked with these conditions as described below in Section 3.3. These inputs differed by decade for 1980-1989, 1990-1999, 2000-2009, and 2010-2019. Finally, these inputs were used with the ALFAM2 model through version 0.3.2 of the ALFAM2 package (Hafner and Haeni, 2020) in R v. 3.6.3 (R Core Team, 2020) to calculate EFs for the four decades. New parameter values ("set 2") were used for these calculations as described below in Section 3.2.

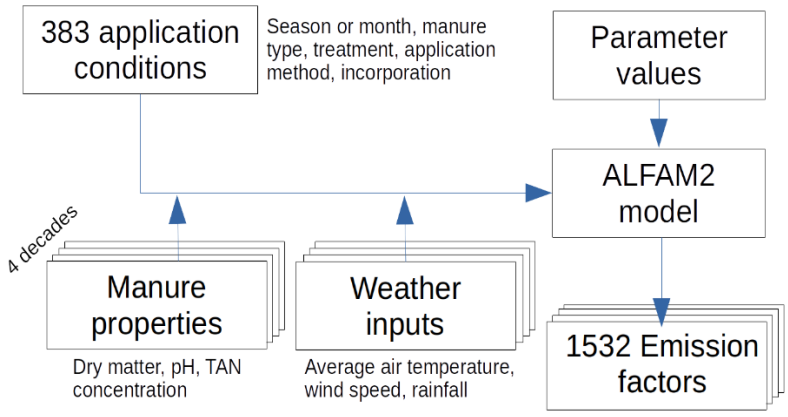


Figure 1. The general process used to calculate new emission factors.

3.1 Summary of ALFAM2 model

The ALFAM2 is semi-empirical and relatively simple (low-order) compared to existing mechanistic models for similar processes (Genermont and Cellier, 1997). It has a structure that reflects the current understanding of physical and chemical processes that drive emission, but with parameter values estimated from emission measurements. The model has been described in detail previously (Hafner et al., 2019) and only a brief summary is given here. In the ALFAM2 model, applied TAN is immediately partitioned between two pools: a "fast" pool, meant to represent TAN in manure exposed to the atmosphere, and a "slow" pool, meant to represent TAN that is less available for emission (e.g., in manure that has infiltrated into the soil) (Fig. 2). Emission continually occurs from both pools, but at a lower rate from the slow pool, and TAN is continually transferred from the fast to the slow pool. Incorporation

is represented by an instantaneous transfer from the fast to slow pool and a reduction in emission from the slow pool, resulting in an overall reduction in emission. Rain can increase the continuous rate of transfer from the fast to slow pool. Parameters that describe partitioning (f0, f4, between 0 and 1) between pools, and transfer rates quantifying emission (r1, r3) or transfer between pools (r2) (all between 0 and ∞) are referred to as primary parameters, and their values determine the magnitude and pattern of emission over time. (See Appendix 2 for an evaluation of the necessity of r3.) Emission is linked to predictor variables (including application techniques and weather variables) through what are referred to as secondary parameters, which quantify the effect of predictor variables on primary parameters. Secondary parameters are completely empirical, being estimated from measurements. Transformations provide plausible quantitative relationships between the value of predictor variables and primary parameters. For example, with an antilog transformation, a fixed manure pH change has a fixed relative effect on emission rate, and with a logistic transformation, incorporation transfers a fixed fraction of the fast pool, always between 0 and 1, to the slow pool.

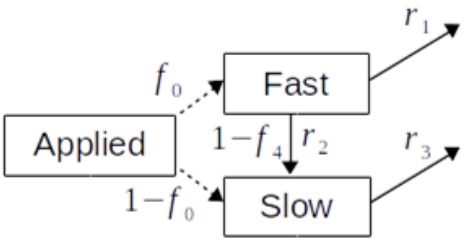


Figure 2. The structure of the ALFAM2 model. Boxes show TAN pools and symbols show primary parameters. Applied TAN is partitioned between "fast" (F) and "slow" (S) pools immediately after application based on the value of f_0. The mass of TAN in these two pools is then calculated over time. Emission of TAN from both pools occurs at a rate (kg ha^{-1} h^{-1}) equal to the product of a first-order constant r_1 or r_3 (h^{-1}) and the pool size (kg ha^{-1} as TAN). Transfer from F to S may occur as a lumped first-order process quantified by r_2 (h^{-1}) or instantly due to incorporation, with partitioning described by f_4.

3.2 Model calibration

A set of secondary parameter values for the ALFAM2 model were presented in Hafner et al. (2019) as part of the "parameterized" ALFAM2 model. These values are available in the ALFAM2 software tools, which consist of an add-on package for the R computing environment (https://www.r-project.org/) and an Excel spreadsheet (see https://alfam.dk for downloads). In the present work new parameters values were calculated to include additional conditions (e.g., closed slot injection) and to ensure that EFs reflected the latest available data for Danish conditions. In this work the original parameter values from Hafner et al. (2019) are referred to as "set 1" and the new set developed and used for calculation of EFs as "set 2". Model parameters used in the calculation of the present EFs include those in set 1 with a few differences. These parameters (i.e., the predictor variables included in the model and a value that quantifies how they interact with emission) were originally selected (as presented in 2019 paper) because: 1) there was an understanding for the observed effect on emission, 2) the associated predictor variable was available for a sufficient fraction of observations, and the empirical secondary parameter value estimated

from emission measurements was 3) neither dependent on the data from a single country nor 4) showed a completely implausible value (Hafner et al., 2019). For parameter set 2, some parameters that affected r_3 were removed, after they were found to be unstable (high uncertainty) during calibration.

The dataset used for development of parameter set 2 (calibration) was a subset of the ALFAM2 database that met several constraints, including availability of predictor variables and measurement by micrometeorological methods (with some exceptions). The dataset used here was largely the same as in the original work (Hafner et al., 2019). However, there were minor corrections to the measurements and other, unrelated, changes, between the version used in the original work (version 1.1) and the present work (version 1.4) (details available at https://github.com/sashahafner/ALFAM2-data/blob/master/ChangeLog). Second, some additional observations were used to estimate parameters for pH and closed slot injection. Third, in the present work, all available observations were used for parameter estimation, while in the original work 10% were reserved for model evaluation. Because evaluation carried out in the original work showed that the model had predictive power (Hafner et al., 2019), and changes in model parameters from set 1 to set 2 were generally small, it was not repeated here. In total, measurements from 648 unique field plots from 6 countries were used. More details on model calibration can be found in Appendix 3.

Changes for parameter set 2 compared to set 1 include addition of parameters for pig manure (versus cattle or other types) and removal of the negative application rate effect for open slot injection, which was implausible and inconsistent with the response observed in a statistical analysis (Hafner et al., 2018). There was no evidence of a meaningful grass or cereal height effect for trailing hose application (parameter estimates smaller than 0.005 cm-1 d-1, compared to -0.2 cm-1 d-1 for cereal with trailing shoe application for r_1) and therefore these effects were not included (despite a clear effect for cereal with trailing shoe application, which is not relevant for these EFs). Parameter values for set 2 are given in Table 1, and these are compared to set 1 in Appendix 3. New parameter values were generally similar to set 1. Exceptions include broadcast application, application rate, wind speed, and incorporation. The effect that these differences have on predictions is shown in Appendix 4. As with set 1, manure pH was included as a continuous quantitative predictor. This approach is supported by the analysis presented in Appendix 5.

Table 1. Parameter values in set 2 used with the ALFAM2 model to calculate new emission factors for Denmark. Reference conditions are trailing hose application of cattle manure. See Appendix 3 for more details.

Primary parameter	Predictor variable	Parameter value
f_0 Initial partitioning (logistic transformation)	Intercept	−0.606
	Open slot injection	−1.74
	Closed slot injection	-7.63
	Application rate (t ha^{-1})*	−0.0111
	Manure dry matter (%)	0.400
	Pig slurry	−0.592
r_1 Fast pool emission rate constant (antilog transformation)	Intercept	−0.939
	Broadcast application	0.794
	Manure dry matter (%)	−0.14
	Manure pH	0.665
	Air temperature (°C)	0.0735
	Wind speed (m s^{-1})	0.150
r_2 Fast-to-slow transfer rate constant (antilog transformation)	Intercept	−1.80
	Rainfall rate (mm h^{-1})	0.394
r_3 Slow pool emission rate constant (antilog transformation)	Intercept	−3.23
	Broadcast application	0.562
	Closed slot injection	-0.666
	Shallow incorporation	−0.581
	Deep incorporation	−1.27
	Manure pH	0.238
f_4 Incorporation partitioning (logistic transformation)	Shallow incorporation	−0.965
	Deep incorporation	−3.69

Notes: * Unlike in the original work (Hafner et al., 2019), this parameter does not apply to open slot injection.

3.3 Input data for calculation of emission factors

Emission factors were calculated for more than 300 unique "application conditions". See Table 2 for a summary of conditions, or Appendix 1 for all conditions.

The following application techniques were included in EFs calculations: broadcast (broadspread), trailing hose, open slot injection, and closed slot (deep) injection (in Danish: bredspredning, udlægning med slæbeslanger, nedfældning i åben rende, and nedfældning i rende der efterfølgende dækkes af jord [sortjordsnedfældning], respectively). Additionally, separate shallow (harrow) and deep (plough) incorporation were considered at specific times following manure application (4, 6, 12, and 24 h), based on regulations, which have changed over time. Incorporation, which occurs after application, differs from injection, which is an application method. EFs were for bare soil, grass, or cereal, and combinations of application method, application period, and crop considered are given in Table 2. No effect of crop height was included in model predictions. Incorporation was combined with trailing hose and broadcast application to bare soil only. For all EFs, manure application rate was fixed at 30 t ha^{-1} (different application rates could have a moderate effect on EFs; sensitivity of emission to application rate can be found in Appendix 4).

Table 2. Application method, timing, and crop combinations that make up the "application conditions" considered for calculation of emission factors. The three types of manure were generally combined with all of these conditions (see Appendix 1 for all conditions). Acidification was applied for most trailing hose and broadcast conditions for cattle and pig manure.

Application method	Application period	Months*	Crop	Crop height (cm)
Open slot injection	March	3	Grass	10
Open slot injection	Summer, grass	5-8	Grass	10
Trailing hose	March	3	Winter cereal	15
Trailing hose	April	4	Winter cereal	25
Trailing hose	May	5	Spring cereal	15
Trailing hose	Summer	6-8	Grass	10
Trailing hose	Autumn	9	Grass	15
Broadcast	Spring-summer	4-8	Cereal and grass	15
Broadcast	Late summer-autumn	7-9	Grass	10
Closed slot injection	March	3	None	
Closed slot injection	April	4	None	
Closed slot injection	Summer, before winter rapeseed	7-8	None	
Closed slot injection	Autumn	9	None	
Trailing hose	March	3	None†	
Trailing hose	April	4	None	
Trailing hose	Summer	6-8	None	
Trailing hose	Autumn	9	None	
Broadcast	Winter-spring	11-3	None	
Broadcast	Winter-spring	11-3	None	
Broadcast	Late summer-autumn	7-9	None	

Notes: *Inclusive, i.e., 5-8 implies all of May, June, July, and August. Shallow and deep incorporation (4, 6, 12, and 24 hours after application, in addition to no incorporation) were also included for all bare soil conditions with trailing hose or broadcast application.

Three types of manure were considered: cattle, pig, and digestate. Average manure composition was determined separately for each decade (except for digestate, which was determined from recent measurements only), based on measurements made on slurry collected from throughout Denmark compiled by the Danish Institute of Agricultural Sciences (now Aarhus University) (Hansen et al., 1989; Sibbesen et al., 1996; Hansen et al., 2008) and the Danish Extension Services SEGES (SEGES, 2018) (Table 3). Pig and cattle manure pH was based only on the latest dataset for all decades (SEGES, 2018). This was done because pH was not available in all the earlier datasets, but also because a combination of measurement error and a high sensitivity of emission to manure pH (Table 1, Appendix 5) makes for a high likelihood of spurious responses if pH varied by decade. The pH values used here were nearly identical to the average of recent measurements made on 8 cattle and 13 pig manure samples from Denmark (Nyord et al., 2021). Digestate composition was based on recent measurements from 15 biogas plants (Møller and Nielsen, 2016), and these data were used for all decades. Acidification was applied to cattle and pig manure only, and was assumed to reduce pH to 6.4 if acid was added during application in the field or to 6.0 for acidification in the barn, and to have no effect on other characteristics.

Table 3. Average manure composition used for calculation of emission factors. Standard deviation in parentheses where available.

Manure type	Decade	Dry matter (%)	pH	Total N (g/kg)	TAN (g/kg)	Source*
Cattle	1980-1989	7.3	7.0†	4.0	2.2	1
	1990-1999	7.0	7.0†	3.9	2.3	2
	2000-2009‡	7.4	7.0†	3.7	2.1	3
	2010-2019	6.5 (1.7)	7.0† (0.35)	3.5 (0.57)	2.1 (0.44)	4
Pig	1980-1989	3.2	7.2†	3.8	2.7	1
	1990-1999	3.7	7.2†	4.6	3.4	2
	2000-2009‡	4.3	7.2†	4.2	3.3	3
	2010-2019	3.9 (2.2)	7.2† (0.39)	4.5 (1.4)	3.3 (0.83)	4
Digestate	All	5.1	7.9	5.2	3.0	5
	2008 EFs‡	4.6	7.7	4.7	3.6	3

Notes:

*Source (except cattle and pig manure pH): 1 Hansen et al. (1989) 1981-1985, *n* = 273 for pig, *n* = 533 for cattle, 2 Sibbesen et al. (1996) for 1996, *n* = 1060 for pig, *n* = 475 for cattle, 3. Hansen et al. (2008) *n* = for pig, *n* = for cattle, 4. SEGES (2018) (M. N. Hansen provided dataset), *n* = 105 for pig, *n* = 67 for cattle, 5. Møller and Nielsen (2016) (H. Møller provided dataset), *n* = 15 biogas plants except total N and TAN where *n* = 18.

†Values for cattle and pig manure pH for all decades were estimated were estimated from source 4 (SEGES, 2018) as described in Section 3.3. For acidification, pH was assumed to be either 6.0 (barn acidification) or 6.4 (field acidification).

‡Also used for earlier calculation of 2008 EFs (Hansen et al., 2008) except pH, which was not used in the calculation of 2008 EFs. Digestate values were included here only for comparison.

Weather data for use in model predictions were kept constant for each condition. Average air temperature measured at 10 m height and wind speed (2 m height) were used (Table 4). Monthly averages, used as inputs, were calculated from daily average values from the Danish Meteorological Institute (DMI) for seven stations: five in Jutland (Tylstrup, Askov, Foulum, Jyndevad, and Silstrup), one on Funen (Aarslev), and one on Zealand (Flakkebjerg). These stations cover the area where a majority of manure is applied in Denmark, and no attempt was made to develop weighted averages. The Danish Centre for Environment and Energy estimates that Jutland accounts for 84% of total manure N application in Denmark (Steen Gyldenkœrne, personal communication). DMI reports wind speed at a height of 10 m, which was adjusted to 2 m in order to match the measurements used for model calibration using a logarithmic profile as given in Guyot (1998, Eq. 2.55). For this calculation the roughness length was fixed at 0.01 m (Foken, 2008). A fixed rainfall rate of 0.09 mm h^{-1} was used for all EFs based on an approximate

value for Jutland of 750 mm yr^{-1}. The analysis presented in Appendix 6 shows that an average rate is sufficiently accurate.

Decade-based inputs, resulting in decade-based EFs, were selected to capture broad changes in climate and manure characteristics. Although annual weather inputs could be used, this level of detail is not available for manure characteristics. Furthermore, annual weather variability would contribute to variation in EFs and total emission unrelated to management.

This simple approach of using constant, average weather inputs for each EF (i.e., treating weather conditions as constant during each simulated emission event) does not fully utilize the capability of the ALFAM2 model, but alternatives are not practical without much more detailed weather input, and any advantage is probably not realized without considering time-of-day effects, which require knowledge about the distribution of application within typical days. This approach was compared to a high-resolution approach in Appendix 6. As shown there, use of average weather inputs had a tendency to underestimate emission compared to high-resolution results. The error is smaller when compared to predictions based on night application (21.00) than morning (9.00) due to higher temperature and wind speeds soon after morning application (7% difference in average emission between morning and night). This error was reduced with small adjustments to average air temperature (+0.9°C) and wind speed (+15%) (Appendix 6), and these adjustments were therefore applied to average weather data used for EF calculations (values are presented in Table 4 do not include these adjustments).

Table 4. Average air temperature (10 m) and wind speed (adjusted to 2 m height) from seven Danish weather stations (six until 11 1999), used in the calculation of emission factors. For EF calculations, these average values were adjusted upward as described in the text.

		Month											
	Decade	1	2	3	4	5	6	7	8	9	10	11	12
Air temp. (°C)	1980-1989*	2.2	2.5	2.4	5.9	11.1	13.9	15.6	14.6	12.7	9.4	4.8	3.4
	1990-1999	1.5	1.7	3.5	6.7	10.8	13.7	16.3	16.6	12.8	8.6	4.3	1.7
	2000-2009	1.9	1.7	3.1	7.6	11.6	14.3	16.8	16.9	13.7	9.4	6.0	2.8
	2010-2019	1.1	1.2	4.0	7.6	11.5	14.6	16.9	16.4	13.7	9.7	5.6	3.0
	2008 EFs†	0.0	0.0	2.1	5.7	10.8	14.3	15.6	15.7	12.7	9.1	4.7	1.6
Wind speed ($m\ s^{-1}$)	1980-1989†	4.0	4.4	3.8	3.3	3.2	2.4	2.9	3.0	3.0	3.5	3.1	3.7
	1990-1999	3.9	4.1	3.9	3.5	3.0	2.9	2.7	2.7	2.9	3.2	3.3	3.5
	2000-2009	3.8	3.4	3.5	3.0	2.9	2.9	2.6	2.6	2.9	3.0	3.4	3.2
	2010-2019	3.6	3.6	3.5	3.4	3.1	2.9	2.7	2.7	3.0	3.1	3.2	3.7
	2008 EFs†	5.6	4.6	4.8	4.9	4.7	4.6	3.8	4.1	4.6	4.6	5.2	5.7
	2008 EFs‡	4.3	3.5	3.7	3.8	3.6	3.5	2.9	3.1	3.5	3.5	4.0	4.4

Notes:

*Based on data from 1987-1989, while others are based on the complete decades.

†From calculation of 2008 emission factors (Hansen et al., 2008), included for comparison and used for comparison of 2008 and new emission factors (see Section 2.4). Average values for all of Denmark for previous 30 years. Wind speed measured at 10 m height and is presented here without adjustment.

‡As with preceding row, but adjusted to a height of 2 m as described in Section 3.3, for comparison.

3.4 Calculation of emission factors

Using the inputs described in Section 2.3, the ALFAM2mod() function from the ALFAM2 R package (Hafner and Haeni, 2020, v0.3.2) was used to calculate cumulative emission 7 days (168 hours) after manure application. In total, 22 parameters were used (Table 1). The use of a fixed duration instead of attempting to estimate ultimate emission (N_{max} in the ALFAM model) as in the earlier EF calculations (Hansen et al., 2008) was based on both the challenge of predicting NH_3 emission over long periods, reflected in the ALFAM2 model structure and recognition that ultimate emission estimates are likely to be overestimates. Estimation of ultimate emission is an extrapolation, and accuracy is not known. As argued previously (Hafner et al., 2019), biological processes begin to affect NH_3 emission in the days following application (Chantigny et al., 2004, 2001; Morvan et al., 1997) and therefore error in extrapolation of emission based on an empirical model and measurements made over 1-3 days may be high. The fixed duration selected for use in calculating EFs is longer than the 3 days (72 hours) used in the original ALFAM2 work (Hafner et al., 2019). Seven days was selected as a balance between under- and over-estimation, as well as a balance between underestimation and extrapolation (considering that many field trials did not extend to 7 days). See Appendix 7 for additional details. Calculated EFs still retain uncertainty related to emission trial duration, as do any EFs, whether calculated directly from measurements or from a model based on measurements.

Cumulative relative emission (fraction of applied TAN) values at 168 hours were taken as the EFs. These EFs then should be applied to the TAN mass transferred to the field through manure application, which will be affected by NH_3 losses during earlier steps in manure management.

All the input files, R code, and output files used to calculate EFs are available from a public GitHub repository: https://github.com/sashahafner/ALFAM2-EF-DK-2021 (see Section 6 for more details). Examples calculations are shown in Appendix 11.

During broadcast application, ammonia is lost as manure travels through the air. This route is not typically measured during emission trials, so is not included in values calculated using the ALFAM2 model. Instead, an estimate was made based on measurements presented in a small number of studies, as described in Appendix 8.

4 Results and discussion

4.1 Performance of models

Evaluation of calculated cumulative emission from the model by comparison to measured emission for all observations used for parameter estimation shows reasonable agreement (Fig. 3). As in the original work, a large fraction of variation in measured emission is not captured by the model, reflecting uncertainty in model predictions (Hafner et al., 2019).

Figure 3. Comparison of 7 day cumulative emission (fraction of applied TAN) calculated using the ALFAM2 model to measurements for all ALFAM2 database observations used for model calibration with cattle or pig slurry (576 plots). Parameters used (set 2) are given in Table 1. Gray lines show 1:1 response. With an ideal response, all points would be close to the 1:1 line.

A comparison of apparent model error for the ALFAM2 model (with parameter set 2, Table 1) and the earlier ALFAM model as used for the 2008 EFs shows some important differences (Fig. 4). Results from the ALFAM2 model generally show better accuracy (median error closer to zero) than the original ALFAM model and the approach taken for the 2008 EFs. In both cases, there is a tendency to overestimate emission (unweighted mean bias error in 7 days cumulative emission as fraction of applied TAN of 0.06 for the ALFAM model and 2008 approach vs. -0.02 for ALFAM2 set 2, both affected by the large number of observations from The Netherlands), although differences varied among countries and application methods. The approach used in 2008 tends to overestimate emission for open and closed slot application. Importantly, ALFAM2 predictions generally showed less spread in errors (Fig. 4,

model efficiency 0.42 vs. 0.63); not only does the newer model appear to be more accurate on balance, but it has higher precision as well. (See Appendix 9 for additional details on model fit.) These results confirm the need for updating emission factors.

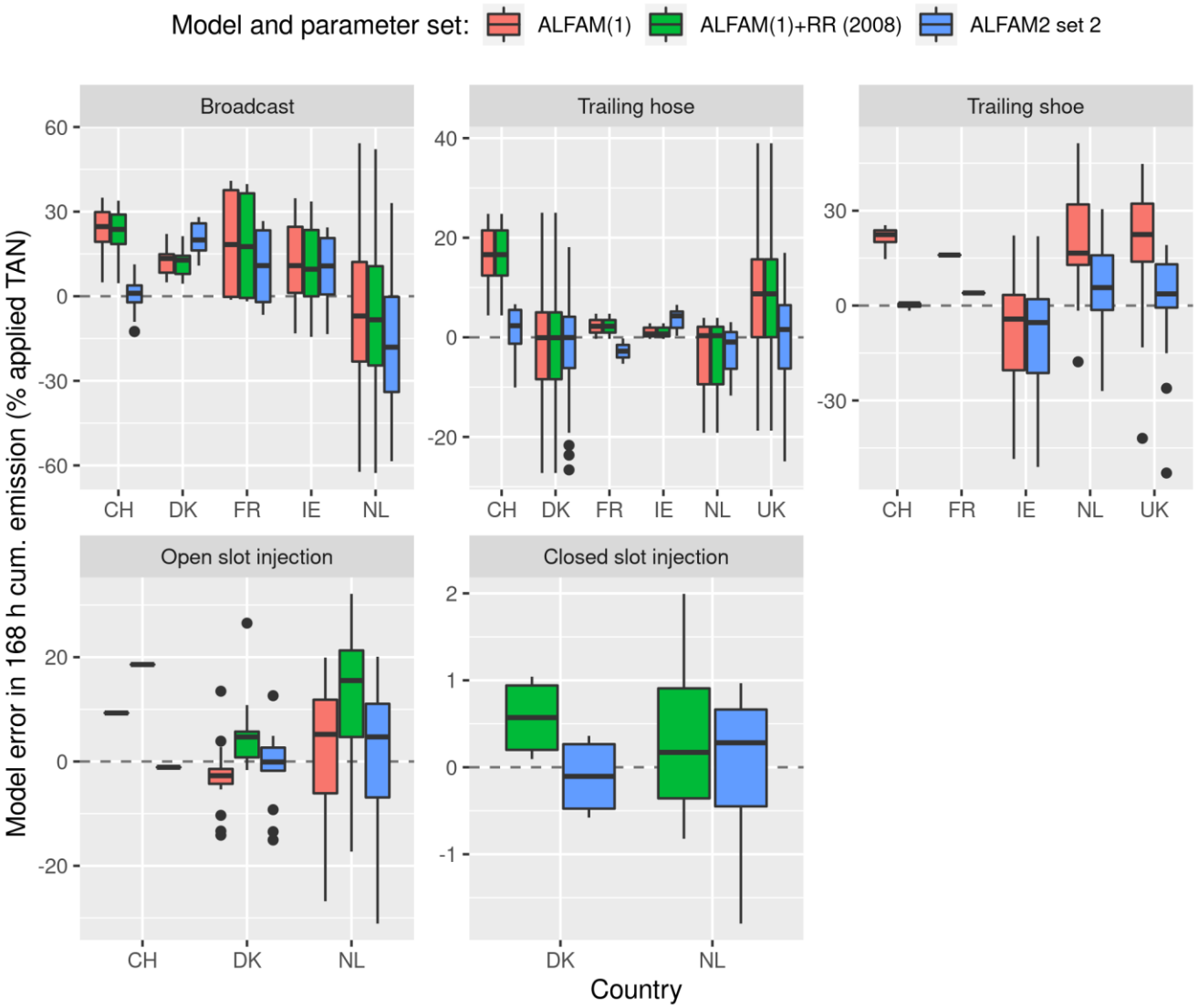


Figure 4. Boxplots of apparent model error (calculated minus measured) in 7 days (or latest available duration, if trial lasted less than 168 h) cumulative emission for the ALFAM model (Søgaard et al., 2002), the ALFAM model with fixed relative reductions (RR) as in 2008 emission factors (see Section 2), and the ALFAM2 model (Hafner et al., 2019) with parameter set 2 (Table 1) for the 449 plots that made up the main calibration dataset (no incorporation, no acidification) plus 8 additional plots with closed slot injection. Error is difference between calculated and measured cumulative emission given as percentage of applied TAN. Positive values indicate overestimation by the model. Boxes show 25th and 75th percentiles, heavy line show median, and whiskers show extreme value (with outliers shown as points).

4.2 Emission factors

In this section, the new EFs are compared to 2008 EFs and then summarized.

4.2.1 Comparison to earlier emission factors

New emission factors calculated as described in Section 2 are different from 2008 EFs (Hansen et al., 2008). New EFs are generally lower for open and closed slot injection conditions (Tables 5 and 6). As described in Section 2, the 2008 EFs were all linked to calculated trailing hose values through a fixed relative reduction, so differences are expected. For trailing hose, new EFs are lower in some cases, and higher in others (Table 7). Some of the trailing hose differences are due to different effects of incorporation. Because the models include parameters for manure source (cattle vs. pig) the differences between 2008 and new EFs will not necessarily be the same for cattle and pig manure, and in fact, tend to be larger for cattle. Relative effects of incorporation, acidification, injection, and digestion differ as well. These changes are related to four main factors:

1. Two different models were used which differ in: a) structure, b) data used for parameter estimation (calibration), and c) approach used for parameter estimation
2. Different general approaches for calculating EFs: use of a model for trailing hose with other conditions based on fixed relative reductions (2008) or use of a model for all EFs (new)
3. The duration over which emission was evaluated differed: ultimate (2008) versus 7 days (new)
4. The way wind speed was handled differed: no consideration of height (2008) versus standardization to 2 m (new)

These four factors are discussed in more detail in Appendix 10.

Table 5. Comparison of new and earlier emission factors for selected conditions for slurry application by closed slot injection to bare soil. Earlier values are from Table 11 in Hansen et al. (2008). New emission factors for close slot injection are nearly constant for all decades. See Appendix 1 for all new emission factors.

		Emission factor (% applied TAN)	
Slurry type	Application period	Hansen et al. 2008	New
Pig	March	0.86	1.8
Pig	April	0.94	1.8
Pig	Summer (before rapeseed)	1.12	1.8
Cattle	March	1.63	1.6
Cattle	April	1.78	1.6
Cattle	Summer (before rapeseed)	2.14	1.6

Table 6. Comparison of new and earlier emission factors for selected conditions for slurry application by open slot injection to soil with grass or cereal. Earlier values are from Table 11 in Hansen et al. (2008). Small differences between new 2000-2009 and 2010-2019 emission factors are due to differences in climate and manure composition. See Appendix 1 for all new emission factors.

		Emission factor (% applied TAN)		
Slurry type	Application period	Hansen et al. 2008	New 2000-2009	New 2010-2019
Pig	March	12.8	9.6	9.7
Pig	April	14	9.8	9.8
Pig	Summer (grass)	15.7-16.8*	10	10
Pig	Autumn	15	10	10
Cattle	March	24.5	12	12
Cattle	April	26.7	13	14
Cattle	Summer (grass)	29.9-32*	15	15
Cattle	Autumn	28.6	15	15

Notes: * Hansen et al. (2008) provided emission factors by month. Where emission factor values for the months given in Table 2 varied, the range is listed.

Table 7. Comparison of new and earlier emission factors for selected conditions with slurry application by trailing hose with and without incorporation. Earlier values are from Tables 10 (without incorporation), Table 13 (shallow incorporation) orTable 12 (deep incorporation) in Hansen et al. (2008). Differences between new 2000-2009 and 2010-2019 emission factors are due to differences in climate and manure composition. See Appendix 1 for all new emission factors.

			Emission factor (% applied TAN)		
Slurry type	Application period	Incorporation	Hansen et al. 2008	New 2000-2009	New 2010-2019
Pig	March	None	13.9	14	14
Pig	April	None	14.8	15	15
Pig	May	None	13.4	15	15
PIg	Summer	None	3.1-19.9*	16	16
Pig	Autumn	None	18.7	15	15
Pig	March	Shallow 4 hr	7.0	5.1	7.5
Pig	April	Shallow 4 hr	7.7	6.0	9.6
PIg	Summer	Shallow 4 hr	9.2	8.7	17
PIg	Autumn	Shallow 4 hr	8.2-8.9*	8.0	15
Pig	March	Deep 4 hr	3.7	2.2	2.4
Pig	April	Deep 4 hr	4.0	3.1	3.5
PIg	Summer	Deep 4 hr	4.8	6.6	6.7
PIg	Autumn	Deep 4 hr	4.7	5.7	5.8
Cattle	March	None	26.4	21	22
Cattle	April	None	28.1	25	27
Cattle	May	None	25.5	29	30
Cattle	Summer	None	6.0-38.0	32	33
Cattle	Autumn	None	35.8	31	32
Cattle	March	Shallow 4 hr	13.4	7.5	8.1
Cattle	April	Shallow 4 hr	13.6	9.6	10
Cattle	Summer	Shallow 4 hr	17.4-17.5*	17	17
Cattle	Autumn	Shallow 4 hr	15.6-17.1*	15	15
Cattle	March	Deep 4 hr	7.0	2.7	3.1
Cattle	April	Deep 4 hr	7.6	4.2	4.7
Cattle	Summer	Deep 4 hr	9.1	11	11
Cattle	Autumn	Deep 4 hr	8.1-8.9*	9.0	9.2

Notes: * Hansen et al. (2008) provided emission factors by month. Where emission factor values for the months given in Table 2 varied, the range is listed.

4.2.2 Summary of emission factors

Overall, EFs range from below 1% of applied TAN for a combination of acidification and incorporation to above 50% for broadcast application of cattle manure without incorporation during warm periods. The discussion below focuses on trailing hose application and effects of incorporation and acidification. Emission factors for injection are also summarized.

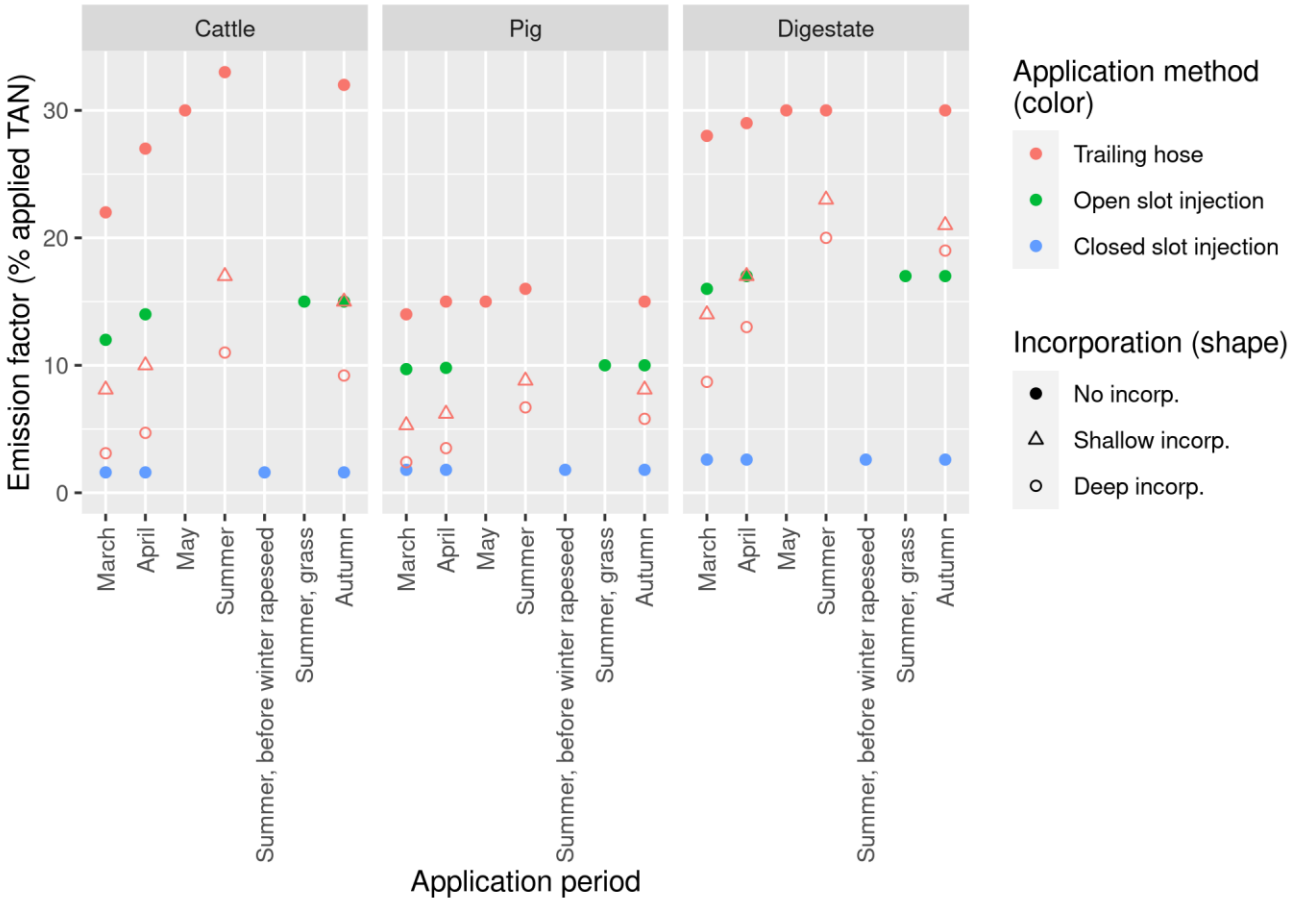


Figure 5. Selected emission factors for trailing hose application and injection as percentage of applied manure TAN (for 2010-2019). When used, incorporation was carried out exactly 4 hours after application. For all emission factors, see Appendix 1.

Incorporation reduces emission by reducing TAN availability or increasing mass transfer resistance. These effects are reflected in the secondary parameters related to r_3 and f_4 as given in Table 1. In both measurements and the ALFAM2 model the rate of ammonia emission peaks soon after application of manure and then declines as TAN is depleted through e.g., emission and infiltration (Hafner et al., 2018, 2019; Huijsmans and de Mol, 1999). Therefore the timing of incorporation determines its efficacy in reducing emission. Deep incorporation 4 hours after trailing hose application is effective, reducing emission by at least 55% (more than 85% for some EFs) (Fig. 5), but this reduction drops substantially as the delay increases. Waiting 24 hours to incorporate leads to smaller reductions, as low as 20% (though up to 50% in some cases). Reductions from shallow incorporation are smaller (Fig. 5). (More details can be found in Appendix 1.) Even with incorporation, EFs respond to weather and manure properties (Fig. 5), primarily due to effects on emission rate prior to incorporation.

Table 8. New (2010-2019) emission factors (% of applied TAN) for manure application by trailing hose (without incorporation), open slot injection to grass, or closed slot injection to bare soil. Cells with no values were not included as EF conditions (EFs were not calculated for these combinations). See Appendix 1 for all new emission factors.

	Trailing hose			Open slot injection			Closed slot injection		
App. period	Cattle	Pig	Digestate	Cattle	Pig	Digestate	Cattle	Pig	Digestate
March				12	9.7	16	1.6	1.8	2.6
April				14	9.8	17	1.6	1.8	2.6
Summer	33	16	30	15	10	17			
Autumn	32	15	30	15	10	17	1.6	1.8	2.6

Ammonia emission is substantially reduced by open slot injection compared to trailing hose (Fig. 5), due to similar mechanisms as those that drive incorporation reductions. Emission factors for open slot injection are somewhat higher than those for deep incorporation (4 hours after application), but overall emission and sensitivity to weather and manure DM and pH are lower (Fig. 5, Table 8). This reduced sensitivity reflects the dominating role of increased mass transfer resistance and perhaps soil sorption and buffering. Emission from open slot injection is affected by the application rate versus "slot volume", and use of equipment with insufficient slot volume could substantially increase emission (Hansen et al., 2003), but this effect is not included in the ALFAM2 model and variation in application rates are not included in EF calculations. (In the EF calculations, it was assumed that manure application rate for all conditions was 30 t ha^{-1} (Section 3.3).)

Although the mechanisms are very different, open slot injection and barn acidification (pH 6.0) have roughly similar effects on EFs (Tables 8 and 9, Appendix 1), which was observed in the trials carried out by Seidel et al. (2017), where field acidification to pH 6.0 provided a similar reduction to open slot injection. With a higher pH assumed for field-acidified manure (pH 6.4), reductions are smaller. Barn acidification reduces EFs by roughly 45% on average while reductions are about 30% for field acidification over all conditions where comparisons are possible. Acidification reduces the chemical activity of free ammonia, NH_3 (aq), within manure, directly reducing the gradient that drives emission without any expected effects on mass transfer resistance or TAN availability. Therefore, the relative effect of acidification is expected to decline over time as TAN depletion becomes more important for untreated manure than acidified manure. This response is apparent in measurements (Bussink et al., 1994; Huijsmans et al., 2015) and reflected in predictions from the ALFAM2 model due to its structure (Fig. 1). For this reason, acidification combined with incorporation will be more effective than expected from individual effects. This mechanism also means that the relative reduction in EFs provided by acidification will not be constant as weather varies, as explained previously (Hafner et al., 2019).

Table 9. Comparison between emission factors (% of applied TAN) for untreated manure and manure acidified in the field (pH 6.4) or barn (pH 6.0) applied by trailing hose (for 2010-2019, without incorporation). See Appendix 1 for all new emission factors.

		Cattle emission factor			Pig emission factor		
App. period	Crop	Untreated	Barn acid.	Field acid.	Untreated	Barn acid.	Field acid.
March	15 cm cereal	23	10	15	14	7.3	9.5
April	25 cm cereal	28	14	19	15	8.4	11
May	15 cm cereal	31	18	23	15	9.5	12
Summer	10 cm grass	33	23	28	16	11	12
Autumn	15 cm grass	32	20	26	15	10	12

Comparing data from different studies where the effect of acidification was quantified is difficult, because manure pH appears to depend on the measurement approach. Huijsmans et al. (2015) showed large variation in measured pH (up to about 0.5 pH units) depending on when and how it was measured: by an online electrode in the acidification/application machinery, in the field after removing a sample, in a sample returned to the laboratory, or in applied manure. It is known that emission of CO_2 will increase manure pH, particularly at the exposed surface (Hafner et al., 2013, 2016; Petersen et al., 2014) and this effect probably causes a gradual increase in manure pH after acidification. Most likely, the pH of manure acidified in the barn is better related to pH of the applied manure than field acidified manure, because the manure has been stored and CO_2 emitted during storage, whereas we suspect that not all CO_2 in the manure has been emitted when manure pH is measured after field acidification. Consequently, we hypothesize that pH does not increase as much in barn acidified manure as in field acidified manure. However, these relationships are not quantitatively known, and this explanation is speculative. These challenges may explain some of the variability observed in the response to acidification, as seen in ALFAM2 parameter values shown in Fig. 2. Additional studies not included in the database continue this pattern of inconsistent responses. For example, measurements available only in a Dutch language report (Huijsmans et al., 2015) show a relatively small effect: 18-32% reduction for a pH reduction from 7.1 or 7.2 to values between 6.0 and 6.5. In contrast, earlier Dutch results in the ALFAM2 database show a larger reduction of 50-70% for acidification to around pH 6.0 (Bussink et al., 1994) and the acidification experiments from Aarhus University included in the ALFAM2 database show a similar reduction for acidification to pH 6.4 (Hafner et al., 2018).

Emission factors for digestate are much higher than corresponding values for pig manure due to higher pH and DM (Table 3, Fig. 5). Digestate EFs also tend to be slightly higher than cattle manure EFs. But cattle manure EFs are actually higher than those for digestate under high-emission conditions (Fig. 5). This response results from digestate having higher pH but lower DM than cattle manure; high pH leads to a higher rate of emission (through r_1 parameter), but the quantity of TAN in the fast pool is limited by lower DM (though f_0 parameter). Under high-emission conditions the quantity of TAN in the fast pool is more important for determining emission than the emission rate constant under these conditions. A difference between untreated manure and digestate is consistent with some recent measurements that show an increase in NH_3 volatilization due to digestion, even in the absence of an increase in DM (Amon et al., 2006; Gericke et al., 2012; Möller and Stinner, 2009; Ni et al., 2012; Rubæk et al., 1996; Sommer et al., 2006). However, available measurements do not show consistent responses, perhaps due to opposing effects of pH increase and DM decrease; some studies show less emission from digestate than raw manure (Pain et al., 1990; Rubæk et al., 1996).

The new EFs reflects a change in anaerobic digestion practice in Denmark, where manure used as digester substrate is now generally mixed with plant biomass or deep litter, resulting in an increase in both pH and DM content (Table 3) than digestate used in the 1990s to the early 2000s referred to by Hansen et al. (2008). It is important to point out that EFs for digestate reported here are not based on a comparison of emission from untreated manure and digestate, but are instead based on the ALFAM2 model response to DM and pH, which are in turn based on the average response observed for many different experiments carried out in multiple countries (DM effect) or on the median effect of acidification observed in a smaller number of acidification experiments (pH effect) (Section 3.2, Appendix 3).

Emission factors presented here reflect changes in manure composition and climate over time. In general, pig manure EFs tend to increase relative to the 1980s, reflecting a slight increase in temperature for most periods. In

contrast, EFs for cattle manure showed less of a trend, with weather effects tempered by a decline in DM. However, changes over time were small, with few EFs changing more than 20% relative to the corresponding 1980s value. The review presented in Appendix 8 resulted in an estimate of 1% of applied TAN lost during broadcast application. This value may be added to the EFs presented in Appendix 1.

5 Conclusions

The new emission factors for NH_3 emission from field-applied manure presented here (Appendix 1) reflect average responses determined in emission measurements made in more than 600 field plots in several European countries. Although subjective elements remain in the calculations presented here (primarily in the estimation of parameter values for the ALFAM2 model and the selection of a duration for predictions) resulting emission factors were calculated in a transparent, repeatable, and largely objective manner. Different from previous values presented in 2008, these new factors are better supported by available emission measurements. The use of a model that represents physical processes that control emission (albeit in a simple way) is expected to provide more accurate values even for combinations of application techniques, weather, and manure properties not represented in available measurements.

We recommend that these new emission factors are used in Danish inventory reporting under NECD and to UNFCC with the use of the different emission factors for the different decades. For 2020 and beyond is recommended to use the emission factors for 2010-2019. For broadcast application in past years, an apparent loss to the air of 1% of applied total ammoniacal nitrogen may be added to the EFs presented in Appendix 1.

If significant changes in manure properties or climate occur in the future, emission factors should be calculated again. Regardless, addition of new measurements to the ALFAM2 database, followed by ALFAM2 model evaluation and refinement will likely continue, and therefore it would be prudent to evaluate emission factors within in the next 5 years.

The emission factors presented in this report are for average Danish conditions. These values are not likely to be accurate for locations with different weather or manure characteristics. Instead, the ALFAM2 model, with parameter values based on measurements made in multiple countries, can be applied with different values for predictor variables, following the approach described in this report. The public can access the model through www.alfam.dk (R package or Excel file), and the R code available through https://github.com/sashahafner/ALFAM2-EF-DK-2021 may serve as a template for carrying out calculations for other locations.

Even with the improvements in emission factors represented by this iteration, the process of estimating emission factors could be improved. Topics that need additional work include: evaluation of rainfall effects, further evaluation (or replacement) of average input variables, more certainty in manure pH, better understanding of acidification and digestion effects, and, as shown by earlier work, better understanding of substantial variability observed in emission measurements.

6 List of appendices

The following appendices are included with this report. In addition, all the data files and R code used to calculate emission factors presented in this report are publicly available at https://github.com/sashahafner/ALFAM2-EF-DK-2021. The results presented in this report are based on commit ad2b7a24d49fcd97eda30d91fee57d3e5a9f4dbf (files from this commit are available from https://github.com/sashahafner/ALFAM2-EF-DK-2021/tree/ad2b7a24d49fcd97eda30d91fee57d3e5a9f4dbf).

Appendix 1. New emission factors and associated application conditions.

Appendix 2. ALFAM2 model structure. Evaluation of emission from the slow pool.

Appendix 3. ALFAM2 model calibration. Calibration information and parameter values.

Appendix 4. ALFAM2 model sensitivity. Predicted emission for various input conditions.

Appendix 5. Manure pH effects. Analysis of the apparent effect of pH on emission and its value as a predictor variable.

Appendix 6. Evaluation of use of average weather inputs in ALFAM2 model, including explanation of input adjustments.

Appendix 7. Emission factor duration. Discussion on the problem of duration for measurements and models and evaluation of the 7 day approach for ALFAM2 emission factor calculation.

Appendix 8. Spreading loss. Estimation of ammonia volatilization during application by broadcast.

Appendix 9. Model fit. Statistics and plots showing model fit for multiple approaches and parameter sets.

Appendix 10. Underlying differences between 2008 and current emission factors. Explanation of the reasons that emission factors differ.

Appendix 11. Example calculation of emission factors. Shown using both ALFAM2 R package and ALFAM2 spreadsheet model.

7 References

Amon, B., Kryvoruchko, V., Amon, T., Zechmeister-Boltenstern, S., 2006. Methane, nitrous oxide and ammonia emissions during storage and after application of dairy cattle slurry and influence of slurry treatment. Agric. Ecosyst. Environ., Mitigation of Greenhouse Gas Emissions from Livestock Production 112, 153–162. https://doi.org/10.1016/j.agee.2005.08.030

Backes, A.M., Aulinger, A., Bieser, J., Matthias, V., Quante, M., 2016. Ammonia emissions in Europe, part II: How ammonia emission abatement strategies affect secondary aerosols. Atmos. Environ. 126, 153–161. https://doi.org/10.1016/j.atmosenv.2015.11.039

Behera, S.N., Sharma, M., Aneja, V.P., Balasubramanian, R., 2013. Ammonia in the atmosphere: a review on emission sources, atmospheric chemistry and deposition on terrestrial bodies. Environ. Sci. Pollut. Res. 20, 8092–8131. https://doi.org/10.1007/s11356-013-2051-9

Bussink, D., Huijsmans, J., Ketelaars, J., 1994. Ammonia Volatilization from Nitric-Acid-Treated Cattle Slurry Surface-Applied to Grassland. Neth. J. Agric. Sci. 42, 293–309.

Carozzi M, Ferrara RM, Rana G, Acutis M. Evaluation of mitigation strategies to reduce ammonia losses from slurry fertilisation on arable lands. Science of The Total Environment 2013;449:126–33. https://doi.org/10.1016/j.scitotenv.2012.12.082.

Chantigny, M.H., Rochette, P., Angers, D.A., 2001. Short-term C and N dynamics in a soil amended with pig slurry and barley straw: a field experiment. Can. J. Soil Sci. 81, 131–137. https://doi.org/10.4141/S00-046

Chantigny, M.H., Rochette, P., Angers, D.A., Massé, D., Côté, D., 2004. Ammonia Volatilization and Selected Soil Characteristics Following Application of Anaerobically Digested Pig Slurry. Soil Sci. Soc. Am. J. 68, 306. https://doi.org/10.2136/sssaj2004.3060

European Parliament, 2016. Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the Reduction of National Emissions of Certain Atmospheric Pollutants, Amending Directive 2003/35/EC and Repealing Directive 2001/81/EC (No. Document 32016L2284). European Council, Brussels.

Foken, T., 2008. Micrometeorology. Springer Berlin Heidelberg, Berlin, Heidelberg.

Genermont, S., Cellier, P., 1997. A mechanistic model for estimating ammonia volatilization from slurry applied to bare soil. Agric. For. Meteorol. 88, 145–167.

Gericke, D., Bornemann, L., Kage, H., Pacholski, A., 2012. Modelling Ammonia Losses After Field Application of Biogas Slurry in Energy Crop Rotations. Water. Air. Soil Pollut. 223, 29–47. https://doi.org/10.1007/s11270-011-0835-4

Goedhart, P.W., Mosquera, J., Huijsmans, J.F.M., 2020. Estimating ammonia emission after field application of manure by the integrated horizontal flux method: a comparison of concentration and wind speed profiles. Soil Use Manag. 36, 338–350. https://doi.org/10.1111/sum.12564

Guyot, G., 1998. Physics of the environment and climate. Wiley.

Haeni, C., Sintermann, J., Kupper, T., Jocher, M., Neftel, A., 2016. Ammonia emission after slurry application to grassland in Switzerland. Atmos. Environ. 125, 92–99. https://doi.org/10.1016/j.atmosenv.2015.10.069

Hafner, S.D., Haeni, C., 2020. ALFAM2 R package [WWW Document]. GitHub. URL https://github.com/sashahafner/ALFAM2 (accessed 7.15.20).

Hafner, S.D., Montes, F., Alan Rotz, C., 2013. The role of carbon dioxide in emission of ammonia from manure. Atmos. Environ. 66, 63–71. https://doi.org/10.1016/j.atmosenv.2012.01.026

Hafner, S.D., Pacholski, A., Bittman, S., Burchill, W., Bussink, W., Chantigny, M., Carozzi, M., Génermont, S., Häni, C., Hansen, M.N., Huijsmans, J., Hunt, D., Kupper, T., Lanigan, G., Loubet, B., Misselbrook, T., Meisinger, J.J., Neftel, A., Nyord, T., Pedersen, S.V., Sintermann, J., Thompson, R.B., Vermeulen, B., Vestergaard, A.V., Voylokov, P., Williams, J.R., Sommer, S.G., 2018. The ALFAM2 database on ammonia emission from field-applied manure: Description and illustrative analysis. Agric. For. Meteorol., Greenhouse gas and ammonia emissions from livestock production 258, 66–79. https://doi.org/10.1016/j.agrformet.2017.11.027

Hafner, S.D., Pacholski, A., Bittman, S., Carozzi, M., Chantigny, M., Génermont, S., Häni, C., Hansen, M.N., Huijsmans, J., Kupper, T., Misselbrook, T., Neftel, A., Nyord, T., Sommer, S.G., 2019. A flexible semi-empirical model for

estimating ammonia volatilization from field-applied slurry. Atmos. Environ. https://doi.org/10.1016/j.atmosenv.2018.11.034
Hafner, S.D., Sommer, S.G., Petersen, V., Markfoged, R., 2016. Effects of carbon dioxide hydration kinetics and evaporative convection on pH profile development during interfacial mass transfer of ammonia and carbon dioxide. Heat Mass Transf. 1–8. https://doi.org/10.1007/s00231-016-1910-6
Hansen, M.N., Sommer, S.G., Hutchings, N.J., Sørensen, P., 2008. Emission factors for calculation of ammonia volatilization by storage and application of animal manure. Aarhus University, Aarhus, DK.
Hansen, M.N., Sommer, S.G., Madsen, N.P., 2003. Reduction of ammonia emission by shallow slurry injection: injection efficiency and additional energy demand. J. Environ. Qual. 32, 1099–1104.
Hertel, O., Geels, C., Frohn, L.M., Ellermann, T., Skjøth, C.A., Løfstrøm, P., Christensen, J.H., Andersen, H.V., Peel, R.G., 2013. Assessing atmospheric nitrogen deposition to natural and semi-natural ecosystems – Experience from Danish studies using the DAMOS. Atmos. Environ., Agriculture and Air Quality: Emission Measurement and Modeling 66, 151–160. https://doi.org/10.1016/j.atmosenv.2012.02.071
Huijsmans, J.F.M., de Mol, R.M., 1999. A model for ammonia volatilization after surface application and subsequent incorporation of manure on arable land. J. Agric. Eng. Res. 74, 73–82. https://doi.org/10.1006/jaer.1999.0438
Huijsmans, J.F.M., Hol, J.M.G., van Schooten, H.A., 2015. Toediening van aangezuurde mest met een sleepvoetenmachine op grasland (629). Wageningen UR, Wageningen NL.
Misselbrook TH, Smith KA, Jackson DR, Gilhespy SL. Ammonia Emissions from Irrigation of Dilute Pig Slurries. Biosystems Engineering 2004;89:473–84. https://doi.org/10.1016/j.biosystemseng.2004.08.015.
Møller, H.B., Nielsen, K.J., 2016. Biogas taskforce – udvikling og effektivisering af biogasproduktionen i Danmark. DCA report 077. DCA - Nationalt Center for Fødevarer og Jordbrug, Tjele, Denmark.
Möller, K., Stinner, W., 2009. Effects of different manuring systems with and without biogas digestion on soil mineral nitrogen content and on gaseous nitrogen losses (ammonia, nitrous oxides). Eur. J. Agron. 30, 1–16. https://doi.org/10.1016/j.eja.2008.06.003
Morvan, T., Leterme, P., Arsene, G.G., Mary, B., 1997. Nitrogen transformations after the spreading of pig slurry on bare soil and ryegrass using 15N-labelled ammonium. Eur. J. Agron. 7, 181–188. https://doi.org/10.1016/S1161-0301(97)00044-0
Nash, J.E., Sutcliffe, J.V. 1970. River flow forecasting through conceptual models part I — A discussion of principles. Journal of Hydrology.10, 282–90. https://doi.org/10.1016/0022-1694(70)90255-6.
Ni, K., Pacholski, A., Gericke, D., Kage, H., 2012. Analysis of ammonia losses after field application of biogas slurries by an empirical model. J. Plant Nutr. Soil Sci. 175, 253–264. https://doi.org/10.1002/jpln.201000358
Nielsen, O.-K., Plejdrup, M.S., Winther, M., Mikkelsen, Mette Hjorth, Nielsen, Malene, Gyldenkœrne, Steen, Fauser, Patrik, Albrektsen, Rikke, Hjelgaard, Katja H., Bruun, Henrik G., Thomsen, Marianne, 2020. Annual Danish Informative Inventory Report to UNECE. Emission Inventories from the Base Year of the Protocols to Year 2018 (Scientific Report No. 369). Aarhus University, DCE – Danish Centre for Environment and Energy.
Nyord, T., Hafner, S.D., Adamsen, A.P., Sommer. S.G. 2020. Ammoniakfordampning fra forsuret gylle ved udbringning med slæbeslange. DCA – Danish Centre For Food And Agriculture. Available online: https://pure.au.dk/portal/files/211563336/Forsuring_150221.pdf
Pain BF, Phillips VR, Clarkson CR, Klarenbeek JV. Loss of nitrogen through ammonia volatilisation during and following the application of pig or cattle slurry to grassland. Journal of the Science of Food and Agriculture 1989;47:1–12. https://doi.org/10.1002/jsfa.2740470102.
Pain, B.F., Thompson, R.B., Rees, Y.J., Skinner, J.H., 1990. Reducing gaseous losses of nitrogen from cattle slurry applied to grassland by the use of additives. J. Sci. Food Agric. 50, 141–153. https://doi.org/10.1002/jsfa.2740500202
Petersen, V., Markfoged, R., Hafner, S.D., Sommer, S.G., 2014. A new slurry pH model accounting for effects of ammonia and carbon dioxide volatilization on solution speciation. Nutr. Cycl. Agroecosystems 1–16. https://doi.org/10.1007/s10705-014-9637-6
R Core Team, 2020. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

Rubæk, G.H., Henriksen, K., Petersen, J., Rasmussen, B., Sommer, S.G., 1996. Effects of application technique and anaerobic digestion on gaseous nitrogen loss from animal slurry applied to ryegrass (Lolium perenne). J. Agric. Sci. 126, 481–492. https://doi.org/10.1017/S0021859600075572

Rumburg B, Mount GH, Yonge D, Lamb B, Westberg H, Filipy J, et al. Atmospheric flux of ammonia from sprinkler application of dairy waste. Atmospheric Environment 2006;40:7246–58. https://doi.org/10.1016/j.atmosenv.2006.04.034.

SEGES, 2018. Notat, Næringsindhold i gylle ab lager. Udtræk af landsforsøgsdatabasen i erioden fra 2008 til 2018. SEGES, Aarhus, Denmark.

Seidel, A., Pacholski, A., Nyord, T., Vestergaard, A., Pahlmann, I., Herrmann, A., Kage, H., 2017. Effects of acidification and injection of pasture applied cattle slurry on ammonia losses, N2O emissions and crop N uptake. Agric. Ecosyst. Environ. 247, 23–32. https://doi.org/10.1016/j.agee.2017.05.030

Sintermann, J., Neftel, A., Ammann, C., Haeni, C., Hensen, A., Loubet, B., Flechard, C.R., 2012. Are ammonia emissions from field-applied slurry substantially over-estimated in European emission inventories? Biogeosciences 9, 1611–1632. https://doi.org/10.5194/bg-9-1611-2012

Søgaard, H.T., Sommer, S.G., Hutchings, N.J., Huijsmans, J.F.M., Bussink, D.W., Nicholson, F., 2002. Ammonia volatilization from field-applied animal slurry—the ALFAM model. Atmos. Environ. 36, 3309–3319. https://doi.org/10.1016/S1352-2310(02)00300-X

Sommer SG. Udspredning af gylle: Fordampning af ammoniak og fordeling af udbragt gylle. Tidsskr Planteavl 1989;93:323–9.

Sommer, S.G., Jensen, L.S., Clausen, S.B., Søgaard, H.T., 2006. Ammonia volatilization from surface-applied livestock slurry as affected by slurry composition and slurry infiltration depth. J. Agric. Sci. 144, 229–235. https://doi.org/10.1017/S0021859606006022

Sommer, S.G., Misselbrook. T.H. 2016. A review of ammonia emission measured using wind tunnels compared with micrometeorological techniques. Soil Use and Management.32,101–8. https://doi.org/10.1111/sum.12209.

Sutton, M.A., Oenema, O., Erisman, J.W., Leip, A., Grinsven, H. van, Winiwarter, W., 2011. Too much of a good thing [WWW Document]. Nature. https://doi.org/10.1038/472159a

Thorman, R.E., Hansen, M.N., Misselbrook, T.H., Sommer, S.G., 2008. Algorithm for estimating the crop height effect on ammonia emission from slurry applied to cereal fields and grassland. Agron. Sustain. Dev. 28, 373–378. https://doi.org/10.1051/agro:2008013

United Nations, 2019. Amendment of the Text and Annexes II to IX to the Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution to Abate Acidification, Eutrophication and Ground-Level Ozone and the Addition of New Annexes X and XI (Reference: C.N.598.2019.TREATIES-XXVII.1.k). United Nations, Geneva.

Walker, J.T., Robarge, W.P., Shendrikar, A., Kimball, H., 2006. Inorganic PM2.5 at a U.S. agricultural site. Environ. Pollut. 139, 258–271. https://doi.org/10.1016/j.envpol.2005.05.019

Wang, J., Yin, Q., Tong, S., Ren, Z., Hu, M., Zhang, H., 2017. Prolonged continuous exposure to high fine particulate matter associated with cardiovascular and respiratory disease mortality in Beijing, China. Atmos. Environ. 168, 1–7. https://doi.org/10.1016/j.atmosenv.2017.08.060

Webb, J., Pain, B., Bittman, S., Morgan, J., 2010. The impacts of manure application methods on emissions of ammonia, nitrous oxide and on crop response-a review. Agric. Ecosyst. Environ. 2010, 137, 39–46, doi:10.1016/j.agee.2010.01.001.

Willmott, C. 1982. Some comments on the evaluation of model performance. Bulletin of the American Meteorological Society. 63, 1309–13.

Willmott, C.J., Matsuura, K. 2005. Advantages of the mean absolute error (MAE) over the root mean square error (RMSE) in assessing average model performance. Climate Research.30, 79.

Appendix 1. Emission factors

Emission factors are shown graphically in Fig. A1.1., and numeric values are given in Tables A.1.1, A1.2, and A1.3 below. Note that these values do not include the small losses during broadcast application (see Section 3.4 and Appendix 8). These emission factors may be downloaded as a comma-delimited text file (*.csv) from the GitHub repository described in Section 6. For a specific commit, see https://github.com/sashahafner/ALFAM2-EF-DK-2021/blob/<*commit*>/emission_factors/output/Appendix_01.csv (with the commit identifier (hash) in place of <commit>), or https://github.com/sashahafner/ALFAM2-EF-DK-2021/blob/main/emission_factors/output/Appendix_01.csv for the latest version.

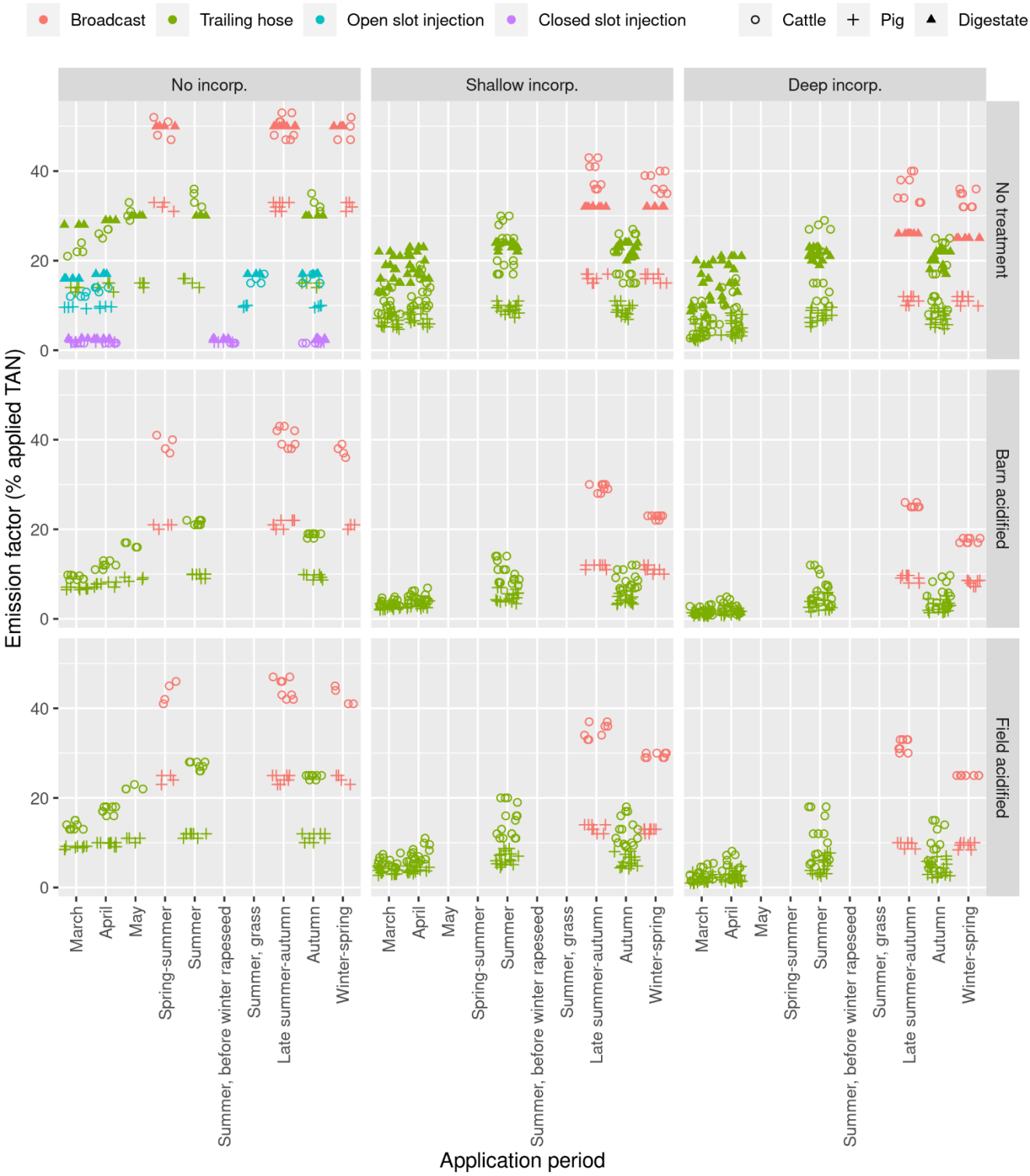


Figure A1.1. New emission factors for all periods, showing effects of timing and various management options. See Tables A1.1, A1.2, and A1.3 for numeric values.

Table A1.1. New emission factors for untreated manure as percentage of applied TAN. Decade column gives the start of each period (e.g., 1980 refers to 1980-1989). Air temperature and wind speed values presented here are adjusted (Section 3.3).

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed ($m\ s^{-1}$)	Rainfall rate ($mm\ h^{-1}$)	Emission factor (%)
017-2010	2010	March	Trailing hose	Winter cereal	15	None	Cattle	6.5	7	4.9	4.02	0.09	22
244-2010	2010	March	Trailing hose	None	0	Shallow 24 hr	Cattle	6.5	7	4.9	4.02	0.09	14
245-2010	2010	March	Trailing hose	None	0	Shallow 12 hr	Cattle	6.5	7	4.9	4.02	0.09	11
246-2010	2010	March	Trailing hose	None	0	Shallow 6 hr	Cattle	6.5	7	4.9	4.02	0.09	8.8
247-2010	2010	March	Trailing hose	None	0	Shallow 4 hr	Cattle	6.5	7	4.9	4.02	0.09	8.1
009-2010	2010	March	Trailing hose	None	0	Deep 24 hr	Cattle	6.5	7	4.9	4.02	0.09	11
010-2010	2010	March	Trailing hose	None	0	Deep 12 hr	Cattle	6.5	7	4.9	4.02	0.09	6.8
011-2010	2010	March	Trailing hose	None	0	Deep 6 hr	Cattle	6.5	7	4.9	4.02	0.09	4.1
012-2010	2010	March	Trailing hose	None	0	Deep 4 hr	Cattle	6.5	7	4.9	4.02	0.09	3.1
054-2010	2010	March	Trailing hose	Winter cereal	15	None	Pig	3.9	7.2	4.9	4.02	0.09	14
264-2010	2010	March	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	7.2	4.9	4.02	0.09	8.6
265-2010	2010	March	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	7.2	4.9	4.02	0.09	7.1
266-2010	2010	March	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	7.2	4.9	4.02	0.09	5.8
267-2010	2010	March	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	7.2	4.9	4.02	0.09	5.3
046-2010	2010	March	Trailing hose	None	0	Deep 24 hr	Pig	3.9	7.2	4.9	4.02	0.09	7
047-2010	2010	March	Trailing hose	None	0	Deep 12 hr	Pig	3.9	7.2	4.9	4.02	0.09	4.9
048-2010	2010	March	Trailing hose	None	0	Deep 6 hr	Pig	3.9	7.2	4.9	4.02	0.09	3.2
049-2010	2010	March	Trailing hose	None	0	Deep 4 hr	Pig	3.9	7.2	4.9	4.02	0.09	2.4
091-2010	2010	March	Trailing hose	Winter cereal	15	None	Digestate	5.1	7.9	4.9	4.02	0.09	28
284-2010	2010	March	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	4.9	4.02	0.09	22
285-2010	2010	March	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	4.9	4.02	0.09	19
286-2010	2010	March	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	4.9	4.02	0.09	16
287-2010	2010	March	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	4.9	4.02	0.09	14
083-2010	2010	March	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	4.9	4.02	0.09	20
084-2010	2010	March	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	4.9	4.02	0.09	16
085-2010	2010	March	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	4.9	4.02	0.09	11
086-2010	2010	March	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	4.9	4.02	0.09	8.7

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
003-2010	2010	March	Open slot injection	Grass	10	Not relevant	Cattle	6.5	7	4.9	4.02	0.09	12
040-2010	2010	March	Open slot injection	Grass	10	Not relevant	Pig	3.9	7.2	4.9	4.02	0.09	9.7
077-2010	2010	March	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	4.9	4.02	0.09	16
001-2010	2010	March	Closed slot injection	None	0	Not relevant	Cattle	6.5	7	4.9	4.02	0.09	1.6
038-2010	2010	March	Closed slot injection	None	0	Not relevant	Pig	3.9	7.2	4.9	4.02	0.09	1.8
075-2010	2010	March	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	4.9	4.02	0.09	2.6
018-2010	2010	April	Trailing hose	Winter cereal	25	None	Cattle	6.5	7	8.5	3.91	0.09	27
248-2010	2010	April	Trailing hose	None	0	Shallow 24 hr	Cattle	6.5	7	8.5	3.91	0.09	19
249-2010	2010	April	Trailing hose	None	0	Shallow 12 hr	Cattle	6.5	7	8.5	3.91	0.09	15
250-2010	2010	April	Trailing hose	None	0	Shallow 6 hr	Cattle	6.5	7	8.5	3.91	0.09	12
251-2010	2010	April	Trailing hose	None	0	Shallow 4 hr	Cattle	6.5	7	8.5	3.91	0.09	10
013-2010	2010	April	Trailing hose	None	0	Deep 24 hr	Cattle	6.5	7	8.5	3.91	0.09	16
014-2010	2010	April	Trailing hose	None	0	Deep 12 hr	Cattle	6.5	7	8.5	3.91	0.09	10
015-2010	2010	April	Trailing hose	None	0	Deep 6 hr	Cattle	6.5	7	8.5	3.91	0.09	6.4
016-2010	2010	April	Trailing hose	None	0	Deep 4 hr	Cattle	6.5	7	8.5	3.91	0.09	4.7
055-2010	2010	April	Trailing hose	Winter cereal	25	None	Pig	3.9	7.2	8.5	3.91	0.09	15
268-2010	2010	April	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	7.2	8.5	3.91	0.09	9.8
269-2010	2010	April	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	7.2	8.5	3.91	0.09	8.5
270-2010	2010	April	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	7.2	8.5	3.91	0.09	7
271-2010	2010	April	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	7.2	8.5	3.91	0.09	6.2
050-2010	2010	April	Trailing hose	None	0	Deep 24 hr	Pig	3.9	7.2	8.5	3.91	0.09	8.3
051-2010	2010	April	Trailing hose	None	0	Deep 12 hr	Pig	3.9	7.2	8.5	3.91	0.09	6.5
052-2010	2010	April	Trailing hose	None	0	Deep 6 hr	Pig	3.9	7.2	8.5	3.91	0.09	4.5
053-2010	2010	April	Trailing hose	None	0	Deep 4 hr	Pig	3.9	7.2	8.5	3.91	0.09	3.5
092-2010	2010	April	Trailing hose	Winter cereal	25	None	Digestate	5.1	7.9	8.5	3.91	0.09	29
288-2010	2010	April	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	8.5	3.91	0.09	23

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
289-2010	2010	April	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	8.5	3.91	0.09	22
290-2010	2010	April	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	8.5	3.91	0.09	19
291-2010	2010	April	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	8.5	3.91	0.09	17
087-2010	2010	April	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	8.5	3.91	0.09	21
088-2010	2010	April	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	8.5	3.91	0.09	20
089-2010	2010	April	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	8.5	3.91	0.09	15
090-2010	2010	April	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	8.5	3.91	0.09	13
004-2010	2010	April	Open slot injection	Grass	10	Not relevant	Cattle	6.5	7	8.5	3.91	0.09	14
041-2010	2010	April	Open slot injection	Grass	10	Not relevant	Pig	3.9	7.2	8.5	3.91	0.09	9.8
078-2010	2010	April	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	8.5	3.91	0.09	17
002-2010	2010	April	Closed slot injection	None	0	Not relevant	Cattle	6.5	7	8.5	3.91	0.09	1.6
039-2010	2010	April	Closed slot injection	None	0	Not relevant	Pig	3.9	7.2	8.5	3.91	0.09	1.8
076-2010	2010	April	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	8.5	3.91	0.09	2.6
019-2010	2010	May	Trailing hose	Spring cereal	15	None	Cattle	6.5	7	12.4	3.56	0.09	30
056-2010	2010	May	Trailing hose	Spring cereal	15	None	Pig	3.9	7.2	12.4	3.56	0.09	15
093-2010	2010	May	Trailing hose	Spring cereal	15	None	Digestate	5.1	7.9	12.4	3.56	0.09	30
033-2010	2010	Spring-summer	Broadcast	Cereal and grass	15	None	Cattle	6.5	7	14.3	3.4	0.09	48
070-2010	2010	Spring-summer	Broadcast	Cereal and grass	15	None	Pig	3.9	7.2	14.3	3.4	0.09	33
107-2010	2010	Spring-summer	Broadcast	Cereal and grass	15	None	Digestate	5.1	7.9	14.3	3.4	0.09	50
020-2010	2010	Summer	Trailing hose	Grass	10	None	Cattle	6.5	7	16.9	3.18	0.09	33
252-2010	2010	Summer	Trailing hose	None	0	Shallow 24 hr	Cattle	6.5	7	16.9	3.18	0.09	29
253-2010	2010	Summer	Trailing hose	None	0	Shallow 12 hr	Cattle	6.5	7	16.9	3.18	0.09	25
254-2010	2010	Summer	Trailing hose	None	0	Shallow 6 hr	Cattle	6.5	7	16.9	3.18	0.09	20

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed ($m\ s^{-1}$)	Rainfall rate ($mm\ h^{-1}$)	Emission factor (%)
255-2010	2010	Summer	Trailing hose	None	0	Shallow 4 hr	Cattle	6.5	7	16.9	3.18	0.09	17
021-2010	2010	Summer	Trailing hose	None	0	Deep 24 hr	Cattle	6.5	7	16.9	3.18	0.09	27
022-2010	2010	Summer	Trailing hose	None	0	Deep 12 hr	Cattle	6.5	7	16.9	3.18	0.09	22
023-2010	2010	Summer	Trailing hose	None	0	Deep 6 hr	Cattle	6.5	7	16.9	3.18	0.09	15
024-2010	2010	Summer	Trailing hose	None	0	Deep 4 hr	Cattle	6.5	7	16.9	3.18	0.09	11
057-2010	2010	Summer	Trailing hose	Grass	10	None	Pig	3.9	7.2	16.9	3.18	0.09	16
272-2010	2010	Summer	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	7.2	16.9	3.18	0.09	11
273-2010	2010	Summer	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	7.2	16.9	3.18	0.09	10
274-2010	2010	Summer	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	7.2	16.9	3.18	0.09	9.6
275-2010	2010	Summer	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	7.2	16.9	3.18	0.09	8.8
058-2010	2010	Summer	Trailing hose	None	0	Deep 24 hr	Pig	3.9	7.2	16.9	3.18	0.09	9.6
059-2010	2010	Summer	Trailing hose	None	0	Deep 12 hr	Pig	3.9	7.2	16.9	3.18	0.09	8.9
060-2010	2010	Summer	Trailing hose	None	0	Deep 6 hr	Pig	3.9	7.2	16.9	3.18	0.09	7.8
061-2010	2010	Summer	Trailing hose	None	0	Deep 4 hr	Pig	3.9	7.2	16.9	3.18	0.09	6.7
094-2010	2010	Summer	Trailing hose	Grass	10	None	Digestate	5.1	7.9	16.9	3.18	0.09	30
292-2010	2010	Summer	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	16.9	3.18	0.09	24
293-2010	2010	Summer	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	16.9	3.18	0.09	24
294-2010	2010	Summer	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	16.9	3.18	0.09	23
295-2010	2010	Summer	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	16.9	3.18	0.09	23
095-2010	2010	Summer	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	16.9	3.18	0.09	23
096-2010	2010	Summer	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	16.9	3.18	0.09	22
097-2010	2010	Summer	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	16.9	3.18	0.09	21
098-2010	2010	Summer	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	16.9	3.18	0.09	20
006-2010	2010	Summer, before winter rapeseed	Closed slot injection	None	0	Not relevant	Cattle	6.5	7	17.5	3.1	0.09	1.6
043-2010	2010	Summer, before winter rapeseed	Closed slot injection	None	0	Not relevant	Pig	3.9	7.2	17.5	3.1	0.09	1.8
080-2010	2010	Summer, before winter rapeseed	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	17.5	3.1	0.09	2.6

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
005-2010	2010	Summer, grass	Open slot injection	Grass	10	Not relevant	Cattle	6.5	7	15.8	3.28	0.09	15
042-2010	2010	Summer, grass	Open slot injection	Grass	10	Not relevant	Pig	3.9	7.2	15.8	3.28	0.09	10
079-2010	2010	Summer, grass	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	15.8	3.28	0.09	17
034-2010	2010	Late summer-autumn	Broadcast	Grass	10	None	Cattle	6.5	7	16.6	3.22	0.09	48
037-2010	2010	Late summer-autumn	Broadcast	None	0	None	Cattle	6.5	7	16.6	3.22	0.09	48
262-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Cattle	6.5	7	16.6	3.22	0.09	37
263-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Cattle	6.5	7	16.6	3.22	0.09	37
035-2010	2010	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Cattle	6.5	7	16.6	3.22	0.09	34
036-2010	2010	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Cattle	6.5	7	16.6	3.22	0.09	34
071-2010	2010	Late summer-autumn	Broadcast	Grass	10	None	Pig	3.9	7.2	16.6	3.22	0.09	33
074-2010	2010	Late summer-autumn	Broadcast	None	0	None	Pig	3.9	7.2	16.6	3.22	0.09	33
282-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Pig	3.9	7.2	16.6	3.22	0.09	17

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
283-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Pig	3.9	7.2	16.6	3.22	0.09	17
072-2010	2010	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Pig	3.9	7.2	16.6	3.22	0.09	12
073-2010	2010	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Pig	3.9	7.2	16.6	3.22	0.09	12
108-2010	2010	Late summer-autumn	Broadcast	Grass	10	None	Digestate	5.1	7.9	16.6	3.22	0.09	50
111-2010	2010	Late summer-autumn	Broadcast	None	0	None	Digestate	5.1	7.9	16.6	3.22	0.09	50
302-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Digestate	5.1	7.9	16.6	3.22	0.09	32
303-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Digestate	5.1	7.9	16.6	3.22	0.09	32
109-2010	2010	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Digestate	5.1	7.9	16.6	3.22	0.09	26
110-2010	2010	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Digestate	5.1	7.9	16.6	3.22	0.09	26
025-2010	2010	Autumn	Trailing hose	Grass	15	None	Cattle	6.5	7	14.6	3.45	0.09	32
256-2010	2010	Autumn	Trailing hose	None	0	Shallow 24 hr	Cattle	6.5	7	14.6	3.45	0.09	26
257-2010	2010	Autumn	Trailing hose	None	0	Shallow 12 hr	Cattle	6.5	7	14.6	3.45	0.09	22
258-2010	2010	Autumn	Trailing hose	None	0	Shallow 6 hr	Cattle	6.5	7	14.6	3.45	0.09	17
259-2010	2010	Autumn	Trailing hose	None	0	Shallow 4 hr	Cattle	6.5	7	14.6	3.45	0.09	15
026-2010	2010	Autumn	Trailing hose	None	0	Deep 24 hr	Cattle	6.5	7	14.6	3.45	0.09	25
027-2010	2010	Autumn	Trailing hose	None	0	Deep 12 hr	Cattle	6.5	7	14.6	3.45	0.09	19
028-2010	2010	Autumn	Trailing hose	None	0	Deep 6 hr	Cattle	6.5	7	14.6	3.45	0.09	12

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
029-2010	2010	Autumn	Trailing hose	None	0	Deep 4 hr	Cattle	6.5	7	14.6	3.45	0.09	9.2
062-2010	2010	Autumn	Trailing hose	Grass	15	None	Pig	3.9	7.2	14.6	3.45	0.09	15
276-2010	2010	Autumn	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	7.2	14.6	3.45	0.09	11
277-2010	2010	Autumn	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	7.2	14.6	3.45	0.09	10
278-2010	2010	Autumn	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	7.2	14.6	3.45	0.09	9
279-2010	2010	Autumn	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	7.2	14.6	3.45	0.09	8.1
063-2010	2010	Autumn	Trailing hose	None	0	Deep 24 hr	Pig	3.9	7.2	14.6	3.45	0.09	9.4
064-2010	2010	Autumn	Trailing hose	None	0	Deep 12 hr	Pig	3.9	7.2	14.6	3.45	0.09	8.6
065-2010	2010	Autumn	Trailing hose	None	0	Deep 6 hr	Pig	3.9	7.2	14.6	3.45	0.09	7
066-2010	2010	Autumn	Trailing hose	None	0	Deep 4 hr	Pig	3.9	7.2	14.6	3.45	0.09	5.8
099-2010	2010	Autumn	Trailing hose	Grass	15	None	Digestate	5.1	7.9	14.6	3.45	0.09	30
296-2010	2010	Autumn	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	14.6	3.45	0.09	24
297-2010	2010	Autumn	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	14.6	3.45	0.09	24
298-2010	2010	Autumn	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	14.6	3.45	0.09	23
299-2010	2010	Autumn	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	14.6	3.45	0.09	21
100-2010	2010	Autumn	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	14.6	3.45	0.09	23
101-2010	2010	Autumn	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	14.6	3.45	0.09	22
102-2010	2010	Autumn	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	14.6	3.45	0.09	21
103-2010	2010	Autumn	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	14.6	3.45	0.09	19
007-2010	2010	Autumn	Open slot injection	Grass	10	Not relevant	Cattle	6.5	7	14.6	3.45	0.09	15
044-2010	2010	Autumn	Open slot injection	Grass	10	Not relevant	Pig	3.9	7.2	14.6	3.45	0.09	10
081-2010	2010	Autumn	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	14.6	3.45	0.09	17
008-2010	2010	Autumn	Closed slot injection	None	0	Not relevant	Cattle	6.5	7	14.6	3.45	0.09	1.6
045-2010	2010	Autumn	Closed slot injection	None	0	Not relevant	Pig	3.9	7.2	14.6	3.45	0.09	1.8
082-2010	2010	Autumn	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	14.6	3.45	0.09	2.6
032-2010	2010	Winter-spring	Broadcast	None	0	None	Cattle	6.5	7	12	3.53	0.09	47
260-2010	2010	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Cattle	6.5	7	12	3.53	0.09	36

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
261-2010	2010	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Cattle	6.5	7	12	3.53	0.09	36
030-2010	2010	Winter-spring	Broadcast	None	0	Deep < 12 hr	Cattle	6.5	7	12	3.53	0.09	32
031-2010	2010	Winter-spring	Broadcast	None	0	Deep > 12 hr	Cattle	6.5	7	12	3.53	0.09	32
069-2010	2010	Winter-spring	Broadcast	None	0	None	Pig	3.9	7.2	12	3.53	0.09	33
280-2010	2010	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Pig	3.9	7.2	12	3.53	0.09	17
281-2010	2010	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Pig	3.9	7.2	12	3.53	0.09	17
067-2010	2010	Winter-spring	Broadcast	None	0	Deep < 12 hr	Pig	3.9	7.2	12	3.53	0.09	12
068-2010	2010	Winter-spring	Broadcast	None	0	Deep > 12 hr	Pig	3.9	7.2	12	3.53	0.09	12
106-2010	2010	Winter-spring	Broadcast	None	0	None	Digestate	5.1	7.9	12	3.53	0.09	50
300-2010	2010	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Digestate	5.1	7.9	12	3.53	0.09	32
301-2010	2010	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Digestate	5.1	7.9	12	3.53	0.09	32
104-2010	2010	Winter-spring	Broadcast	None	0	Deep < 12 hr	Digestate	5.1	7.9	12	3.53	0.09	25
105-2010	2010	Winter-spring	Broadcast	None	0	Deep > 12 hr	Digestate	5.1	7.9	12	3.53	0.09	25
017-2000	2000	March	Trailing hose	Winter cereal	15	None	Cattle	6.4	7	4	4.02	0.09	21
244-2000	2000	March	Trailing hose	None	0	Shallow 24 hr	Cattle	6.4	7	4	4.02	0.09	13
245-2000	2000	March	Trailing hose	None	0	Shallow 12 hr	Cattle	6.4	7	4	4.02	0.09	9.9
246-2000	2000	March	Trailing hose	None	0	Shallow 6 hr	Cattle	6.4	7	4	4.02	0.09	8.1
247-2000	2000	March	Trailing hose	None	0	Shallow 4 hr	Cattle	6.4	7	4	4.02	0.09	7.5
009-2000	2000	March	Trailing hose	None	0	Deep 24 hr	Cattle	6.4	7	4	4.02	0.09	9.7
010-2000	2000	March	Trailing hose	None	0	Deep 12 hr	Cattle	6.4	7	4	4.02	0.09	6
011-2000	2000	March	Trailing hose	None	0	Deep 6 hr	Cattle	6.4	7	4	4.02	0.09	3.6

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
012-2000	2000	March	Trailing hose	None	0	Deep 4 hr	Cattle	6.4	7	4	4.02	0.09	2.7
054-2000	2000	March	Trailing hose	Winter cereal	15	None	Pig	3.9	7.2	4	4.02	0.09	14
264-2000	2000	March	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	7.2	4	4.02	0.09	8.3
265-2000	2000	March	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	7.2	4	4.02	0.09	6.7
266-2000	2000	March	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	7.2	4	4.02	0.09	5.6
267-2000	2000	March	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	7.2	4	4.02	0.09	5.1
046-2000	2000	March	Trailing hose	None	0	Deep 24 hr	Pig	3.9	7.2	4	4.02	0.09	6.5
047-2000	2000	March	Trailing hose	None	0	Deep 12 hr	Pig	3.9	7.2	4	4.02	0.09	4.5
048-2000	2000	March	Trailing hose	None	0	Deep 6 hr	Pig	3.9	7.2	4	4.02	0.09	2.9
049-2000	2000	March	Trailing hose	None	0	Deep 4 hr	Pig	3.9	7.2	4	4.02	0.09	2.2
091-2000	2000	March	Trailing hose	Winter cereal	15	None	Digestate	5.1	7.9	4	4.02	0.09	28
284-2000	2000	March	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	4	4.02	0.09	21
285-2000	2000	March	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	4	4.02	0.09	18
286-2000	2000	March	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	4	4.02	0.09	15
287-2000	2000	March	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	4	4.02	0.09	13
083-2000	2000	March	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	4	4.02	0.09	19
084-2000	2000	March	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	4	4.02	0.09	15
085-2000	2000	March	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	4	4.02	0.09	10
086-2000	2000	March	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	4	4.02	0.09	7.8
003-2000	2000	March	Open slot injection	Grass	10	Not relevant	Cattle	6.4	7	4	4.02	0.09	12
040-2000	2000	March	Open slot injection	Grass	10	Not relevant	Pig	3.9	7.2	4	4.02	0.09	9.6
077-2000	2000	March	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	4	4.02	0.09	16
001-2000	2000	March	Closed slot injection	None	0	Not relevant	Cattle	6.4	7	4	4.02	0.09	1.6
038-2000	2000	March	Closed slot injection	None	0	Not relevant	Pig	3.9	7.2	4	4.02	0.09	1.8
075-2000	2000	March	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	4	4.02	0.09	2.6
018-2000	2000	April	Trailing hose	Winter cereal	25	None	Cattle	6.4	7	8.5	3.45	0.09	25

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
248-2000	2000	April	Trailing hose	None	0	Shallow 24 hr	Cattle	6.4	7	8.5	3.45	0.09	17
249-2000	2000	April	Trailing hose	None	0	Shallow 12 hr	Cattle	6.4	7	8.5	3.45	0.09	13
250-2000	2000	April	Trailing hose	None	0	Shallow 6 hr	Cattle	6.4	7	8.5	3.45	0.09	11
251-2000	2000	April	Trailing hose	None	0	Shallow 4 hr	Cattle	6.4	7	8.5	3.45	0.09	9.6
013-2000	2000	April	Trailing hose	None	0	Deep 24 hr	Cattle	6.4	7	8.5	3.45	0.09	14
014-2000	2000	April	Trailing hose	None	0	Deep 12 hr	Cattle	6.4	7	8.5	3.45	0.09	9.3
015-2000	2000	April	Trailing hose	None	0	Deep 6 hr	Cattle	6.4	7	8.5	3.45	0.09	5.6
016-2000	2000	April	Trailing hose	None	0	Deep 4 hr	Cattle	6.4	7	8.5	3.45	0.09	4.2
055-2000	2000	April	Trailing hose	Winter cereal	25	None	Pig	3.9	7.2	8.5	3.45	0.09	15
268-2000	2000	April	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	7.2	8.5	3.45	0.09	9.5
269-2000	2000	April	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	7.2	8.5	3.45	0.09	8.1
270-2000	2000	April	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	7.2	8.5	3.45	0.09	6.6
271-2000	2000	April	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	7.2	8.5	3.45	0.09	6
050-2000	2000	April	Trailing hose	None	0	Deep 24 hr	Pig	3.9	7.2	8.5	3.45	0.09	8
051-2000	2000	April	Trailing hose	None	0	Deep 12 hr	Pig	3.9	7.2	8.5	3.45	0.09	6.1
052-2000	2000	April	Trailing hose	None	0	Deep 6 hr	Pig	3.9	7.2	8.5	3.45	0.09	4.1
053-2000	2000	April	Trailing hose	None	0	Deep 4 hr	Pig	3.9	7.2	8.5	3.45	0.09	3.1
092-2000	2000	April	Trailing hose	Winter cereal	25	None	Digestate	5.1	7.9	8.5	3.45	0.09	29
288-2000	2000	April	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	8.5	3.45	0.09	23
289-2000	2000	April	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	8.5	3.45	0.09	21
290-2000	2000	April	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	8.5	3.45	0.09	18
291-2000	2000	April	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	8.5	3.45	0.09	16
087-2000	2000	April	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	8.5	3.45	0.09	21
088-2000	2000	April	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	8.5	3.45	0.09	19
089-2000	2000	April	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	8.5	3.45	0.09	14
090-2000	2000	April	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	8.5	3.45	0.09	11
004-2000	2000	April	Open slot injection	Grass	10	Not relevant	Cattle	6.4	7	8.5	3.45	0.09	13
041-2000	2000	April	Open slot injection	Grass	10	Not relevant	Pig	3.9	7.2	8.5	3.45	0.09	9.8
078-2000	2000	April	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	8.5	3.45	0.09	17

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
002-2000	2000	April	Closed slot injection	None	0	Not relevant	Cattle	6.4	7	8.5	3.45	0.09	1.6
039-2000	2000	April	Closed slot injection	None	0	Not relevant	Pig	3.9	7.2	8.5	3.45	0.09	1.8
076-2000	2000	April	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	8.5	3.45	0.09	2.6
019-2000	2000	May	Trailing hose	Spring cereal	15	None	Cattle	6.4	7	12.5	3.33	0.09	29
056-2000	2000	May	Trailing hose	Spring cereal	15	None	Pig	3.9	7.2	12.5	3.33	0.09	15
093-2000	2000	May	Trailing hose	Spring cereal	15	None	Digestate	5.1	7.9	12.5	3.33	0.09	30
033-2000	2000	Spring-summer	Broadcast	Cereal and grass	15	None	Cattle	6.4	7	14.3	3.22	0.09	47
070-2000	2000	Spring-summer	Broadcast	Cereal and grass	15	None	Pig	3.9	7.2	14.3	3.22	0.09	33
107-2000	2000	Spring-summer	Broadcast	Cereal and grass	15	None	Digestate	5.1	7.9	14.3	3.22	0.09	50
020-2000	2000	Summer	Trailing hose	Grass	10	None	Cattle	6.4	7	16.9	3.1	0.09	32
252-2000	2000	Summer	Trailing hose	None	0	Shallow 24 hr	Cattle	6.4	7	16.9	3.1	0.09	28
253-2000	2000	Summer	Trailing hose	None	0	Shallow 12 hr	Cattle	6.4	7	16.9	3.1	0.09	24
254-2000	2000	Summer	Trailing hose	None	0	Shallow 6 hr	Cattle	6.4	7	16.9	3.1	0.09	19
255-2000	2000	Summer	Trailing hose	None	0	Shallow 4 hr	Cattle	6.4	7	16.9	3.1	0.09	17
021-2000	2000	Summer	Trailing hose	None	0	Deep 24 hr	Cattle	6.4	7	16.9	3.1	0.09	27
022-2000	2000	Summer	Trailing hose	None	0	Deep 12 hr	Cattle	6.4	7	16.9	3.1	0.09	22
023-2000	2000	Summer	Trailing hose	None	0	Deep 6 hr	Cattle	6.4	7	16.9	3.1	0.09	15
024-2000	2000	Summer	Trailing hose	None	0	Deep 4 hr	Cattle	6.4	7	16.9	3.1	0.09	11
057-2000	2000	Summer	Trailing hose	Grass	10	None	Pig	3.9	7.2	16.9	3.1	0.09	16
272-2000	2000	Summer	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	7.2	16.9	3.1	0.09	11
273-2000	2000	Summer	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	7.2	16.9	3.1	0.09	10
274-2000	2000	Summer	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	7.2	16.9	3.1	0.09	9.5
275-2000	2000	Summer	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	7.2	16.9	3.1	0.09	8.7
058-2000	2000	Summer	Trailing hose	None	0	Deep 24 hr	Pig	3.9	7.2	16.9	3.1	0.09	9.5
059-2000	2000	Summer	Trailing hose	None	0	Deep 12 hr	Pig	3.9	7.2	16.9	3.1	0.09	8.9
060-2000	2000	Summer	Trailing hose	None	0	Deep 6 hr	Pig	3.9	7.2	16.9	3.1	0.09	7.7

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
061-2000	2000	Summer	Trailing hose	None	0	Deep 4 hr	Pig	3.9	7.2	16.9	3.1	0.09	6.6
094-2000	2000	Summer	Trailing hose	Grass	10	None	Digestate	5.1	7.9	16.9	3.1	0.09	30
292-2000	2000	Summer	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	16.9	3.1	0.09	24
293-2000	2000	Summer	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	16.9	3.1	0.09	24
294-2000	2000	Summer	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	16.9	3.1	0.09	23
295-2000	2000	Summer	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	16.9	3.1	0.09	22
095-2000	2000	Summer	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	16.9	3.1	0.09	23
096-2000	2000	Summer	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	16.9	3.1	0.09	22
097-2000	2000	Summer	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	16.9	3.1	0.09	21
098-2000	2000	Summer	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	16.9	3.1	0.09	20
006-2000	2000	Summer, before winter rapeseed	Closed slot injection	None	0	Not relevant	Cattle	6.4	7	17.8	2.99	0.09	1.6
043-2000	2000	Summer, before winter rapeseed	Closed slot injection	None	0	Not relevant	Pig	3.9	7.2	17.8	2.99	0.09	1.8
080-2000	2000	Summer, before winter rapeseed	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	17.8	2.99	0.09	2.6
005-2000	2000	Summer, grass	Open slot injection	Grass	10	Not relevant	Cattle	6.4	7	15.8	3.16	0.09	15
042-2000	2000	Summer, grass	Open slot injection	Grass	10	Not relevant	Pig	3.9	7.2	15.8	3.16	0.09	10
079-2000	2000	Summer, grass	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	15.8	3.16	0.09	17
034-2000	2000	Late summer-autumn	Broadcast	Grass	10	None	Cattle	6.4	7	16.7	3.1	0.09	47
037-2000	2000	Late summer-autumn	Broadcast	None	0	None	Cattle	6.4	7	16.7	3.1	0.09	47

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
262-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Cattle	6.4	7	16.7	3.1	0.09	36
263-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Cattle	6.4	7	16.7	3.1	0.09	36
035-2000	2000	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Cattle	6.4	7	16.7	3.1	0.09	33
036-2000	2000	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Cattle	6.4	7	16.7	3.1	0.09	33
071-2000	2000	Late summer-autumn	Broadcast	Grass	10	None	Pig	3.9	7.2	16.7	3.1	0.09	33
074-2000	2000	Late summer-autumn	Broadcast	None	0	None	Pig	3.9	7.2	16.7	3.1	0.09	33
282-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Pig	3.9	7.2	16.7	3.1	0.09	17
283-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Pig	3.9	7.2	16.7	3.1	0.09	17
072-2000	2000	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Pig	3.9	7.2	16.7	3.1	0.09	12
073-2000	2000	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Pig	3.9	7.2	16.7	3.1	0.09	12
108-2000	2000	Late summer-autumn	Broadcast	Grass	10	None	Digestate	5.1	7.9	16.7	3.1	0.09	50

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
111-2000	2000	Late summer-autumn	Broadcast	None	0	None	Digestate	5.1	7.9	16.7	3.1	0.09	50
302-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Digestate	5.1	7.9	16.7	3.1	0.09	32
303-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Digestate	5.1	7.9	16.7	3.1	0.09	32
109-2000	2000	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Digestate	5.1	7.9	16.7	3.1	0.09	26
110-2000	2000	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Digestate	5.1	7.9	16.7	3.1	0.09	26
025-2000	2000	Autumn	Trailing hose	Grass	15	None	Cattle	6.4	7	14.6	3.33	0.09	31
256-2000	2000	Autumn	Trailing hose	None	0	Shallow 24 hr	Cattle	6.4	7	14.6	3.33	0.09	26
257-2000	2000	Autumn	Trailing hose	None	0	Shallow 12 hr	Cattle	6.4	7	14.6	3.33	0.09	21
258-2000	2000	Autumn	Trailing hose	None	0	Shallow 6 hr	Cattle	6.4	7	14.6	3.33	0.09	17
259-2000	2000	Autumn	Trailing hose	None	0	Shallow 4 hr	Cattle	6.4	7	14.6	3.33	0.09	15
026-2000	2000	Autumn	Trailing hose	None	0	Deep 24 hr	Cattle	6.4	7	14.6	3.33	0.09	24
027-2000	2000	Autumn	Trailing hose	None	0	Deep 12 hr	Cattle	6.4	7	14.6	3.33	0.09	18
028-2000	2000	Autumn	Trailing hose	None	0	Deep 6 hr	Cattle	6.4	7	14.6	3.33	0.09	12
029-2000	2000	Autumn	Trailing hose	None	0	Deep 4 hr	Cattle	6.4	7	14.6	3.33	0.09	9
062-2000	2000	Autumn	Trailing hose	Grass	15	None	Pig	3.9	7.2	14.6	3.33	0.09	15
276-2000	2000	Autumn	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	7.2	14.6	3.33	0.09	11
277-2000	2000	Autumn	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	7.2	14.6	3.33	0.09	10
278-2000	2000	Autumn	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	7.2	14.6	3.33	0.09	8.9
279-2000	2000	Autumn	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	7.2	14.6	3.33	0.09	8
063-2000	2000	Autumn	Trailing hose	None	0	Deep 24 hr	Pig	3.9	7.2	14.6	3.33	0.09	9.4
064-2000	2000	Autumn	Trailing hose	None	0	Deep 12 hr	Pig	3.9	7.2	14.6	3.33	0.09	8.5
065-2000	2000	Autumn	Trailing hose	None	0	Deep 6 hr	Pig	3.9	7.2	14.6	3.33	0.09	6.9
066-2000	2000	Autumn	Trailing hose	None	0	Deep 4 hr	Pig	3.9	7.2	14.6	3.33	0.09	5.7
099-2000	2000	Autumn	Trailing hose	Grass	15	None	Digestate	5.1	7.9	14.6	3.33	0.09	30
296-2000	2000	Autumn	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	14.6	3.33	0.09	24

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
297-2000	2000	Autumn	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	14.6	3.33	0.09	24
298-2000	2000	Autumn	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	14.6	3.33	0.09	23
299-2000	2000	Autumn	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	14.6	3.33	0.09	21
100-2000	2000	Autumn	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	14.6	3.33	0.09	22
101-2000	2000	Autumn	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	14.6	3.33	0.09	22
102-2000	2000	Autumn	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	14.6	3.33	0.09	20
103-2000	2000	Autumn	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	14.6	3.33	0.09	18
007-2000	2000	Autumn	Open slot injection	Grass	10	Not relevant	Cattle	6.4	7	14.6	3.33	0.09	15
044-2000	2000	Autumn	Open slot injection	Grass	10	Not relevant	Pig	3.9	7.2	14.6	3.33	0.09	10
081-2000	2000	Autumn	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	14.6	3.33	0.09	17
008-2000	2000	Autumn	Closed slot injection	None	0	Not relevant	Cattle	6.4	7	14.6	3.33	0.09	1.6
045-2000	2000	Autumn	Closed slot injection	None	0	Not relevant	Pig	3.9	7.2	14.6	3.33	0.09	1.8
082-2000	2000	Autumn	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	14.6	3.33	0.09	2.6
032-2000	2000	Winter-spring	Broadcast	None	0	None	Cattle	6.4	7	11.9	3.42	0.09	47
260-2000	2000	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Cattle	6.4	7	11.9	3.42	0.09	35
261-2000	2000	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Cattle	6.4	7	11.9	3.42	0.09	35
030-2000	2000	Winter-spring	Broadcast	None	0	Deep < 12 hr	Cattle	6.4	7	11.9	3.42	0.09	32
031-2000	2000	Winter-spring	Broadcast	None	0	Deep > 12 hr	Cattle	6.4	7	11.9	3.42	0.09	32
069-2000	2000	Winter-spring	Broadcast	None	0	None	Pig	3.9	7.2	11.9	3.42	0.09	33
280-2000	2000	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Pig	3.9	7.2	11.9	3.42	0.09	17
281-2000	2000	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Pig	3.9	7.2	11.9	3.42	0.09	17

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
067-2000	2000	Winter-spring	Broadcast	None	0	Deep < 12 hr	Pig	3.9	7.2	11.9	3.42	0.09	12
068-2000	2000	Winter-spring	Broadcast	None	0	Deep > 12 hr	Pig	3.9	7.2	11.9	3.42	0.09	12
106-2000	2000	Winter-spring	Broadcast	None	0	None	Digestate	5.1	7.9	11.9	3.42	0.09	50
300-2000	2000	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Digestate	5.1	7.9	11.9	3.42	0.09	32
301-2000	2000	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Digestate	5.1	7.9	11.9	3.42	0.09	32
104-2000	2000	Winter-spring	Broadcast	None	0	Deep < 12 hr	Digestate	5.1	7.9	11.9	3.42	0.09	25
105-2000	2000	Winter-spring	Broadcast	None	0	Deep > 12 hr	Digestate	5.1	7.9	11.9	3.42	0.09	25
017-1990	1990	March	Trailing hose	Winter cereal	15	None	Cattle	7	7	4.4	4.48	0.09	24
244-1990	1990	March	Trailing hose	None	0	Shallow 24 hr	Cattle	7	7	4.4	4.48	0.09	15
245-1990	1990	March	Trailing hose	None	0	Shallow 12 hr	Cattle	7	7	4.4	4.48	0.09	11
246-1990	1990	March	Trailing hose	None	0	Shallow 6 hr	Cattle	7	7	4.4	4.48	0.09	9.3
247-1990	1990	March	Trailing hose	None	0	Shallow 4 hr	Cattle	7	7	4.4	4.48	0.09	8.5
009-1990	1990	March	Trailing hose	None	0	Deep 24 hr	Cattle	7	7	4.4	4.48	0.09	11
010-1990	1990	March	Trailing hose	None	0	Deep 12 hr	Cattle	7	7	4.4	4.48	0.09	7.1
011-1990	1990	March	Trailing hose	None	0	Deep 6 hr	Cattle	7	7	4.4	4.48	0.09	4.3
012-1990	1990	March	Trailing hose	None	0	Deep 4 hr	Cattle	7	7	4.4	4.48	0.09	3.2
054-1990	1990	March	Trailing hose	Winter cereal	15	None	Pig	3.7	7.2	4.4	4.48	0.09	14
264-1990	1990	March	Trailing hose	None	0	Shallow 24 hr	Pig	3.7	7.2	4.4	4.48	0.09	8.5
265-1990	1990	March	Trailing hose	None	0	Shallow 12 hr	Pig	3.7	7.2	4.4	4.48	0.09	7.1
266-1990	1990	March	Trailing hose	None	0	Shallow 6 hr	Pig	3.7	7.2	4.4	4.48	0.09	5.8
267-1990	1990	March	Trailing hose	None	0	Shallow 4 hr	Pig	3.7	7.2	4.4	4.48	0.09	5.3
046-1990	1990	March	Trailing hose	None	0	Deep 24 hr	Pig	3.7	7.2	4.4	4.48	0.09	6.9
047-1990	1990	March	Trailing hose	None	0	Deep 12 hr	Pig	3.7	7.2	4.4	4.48	0.09	5
048-1990	1990	March	Trailing hose	None	0	Deep 6 hr	Pig	3.7	7.2	4.4	4.48	0.09	3.3
049-1990	1990	March	Trailing hose	None	0	Deep 4 hr	Pig	3.7	7.2	4.4	4.48	0.09	2.5

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
091-1990	1990	March	Trailing hose	Winter cereal	15	None	Digestate	5.1	7.9	4.4	4.48	0.09	28
284-1990	1990	March	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	4.4	4.48	0.09	22
285-1990	1990	March	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	4.4	4.48	0.09	19
286-1990	1990	March	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	4.4	4.48	0.09	16
287-1990	1990	March	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	4.4	4.48	0.09	14
083-1990	1990	March	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	4.4	4.48	0.09	20
084-1990	1990	March	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	4.4	4.48	0.09	17
085-1990	1990	March	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	4.4	4.48	0.09	12
086-1990	1990	March	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	4.4	4.48	0.09	9.1
003-1990	1990	March	Open slot injection	Grass	10	Not relevant	Cattle	7	7	4.4	4.48	0.09	13
040-1990	1990	March	Open slot injection	Grass	10	Not relevant	Pig	3.7	7.2	4.4	4.48	0.09	9.6
077-1990	1990	March	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	4.4	4.48	0.09	16
001-1990	1990	March	Closed slot injection	None	0	Not relevant	Cattle	7	7	4.4	4.48	0.09	1.6
038-1990	1990	March	Closed slot injection	None	0	Not relevant	Pig	3.7	7.2	4.4	4.48	0.09	1.8
075-1990	1990	March	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	4.4	4.48	0.09	2.6
018-1990	1990	April	Trailing hose	Winter cereal	25	None	Cattle	7	7	7.6	4.02	0.09	27
248-1990	1990	April	Trailing hose	None	0	Shallow 24 hr	Cattle	7	7	7.6	4.02	0.09	18
249-1990	1990	April	Trailing hose	None	0	Shallow 12 hr	Cattle	7	7	7.6	4.02	0.09	14
250-1990	1990	April	Trailing hose	None	0	Shallow 6 hr	Cattle	7	7	7.6	4.02	0.09	11
251-1990	1990	April	Trailing hose	None	0	Shallow 4 hr	Cattle	7	7	7.6	4.02	0.09	10
013-1990	1990	April	Trailing hose	None	0	Deep 24 hr	Cattle	7	7	7.6	4.02	0.09	15
014-1990	1990	April	Trailing hose	None	0	Deep 12 hr	Cattle	7	7	7.6	4.02	0.09	9.6
015-1990	1990	April	Trailing hose	None	0	Deep 6 hr	Cattle	7	7	7.6	4.02	0.09	5.8
016-1990	1990	April	Trailing hose	None	0	Deep 4 hr	Cattle	7	7	7.6	4.02	0.09	4.3
055-1990	1990	April	Trailing hose	Winter cereal	25	None	Pig	3.7	7.2	7.6	4.02	0.09	14
268-1990	1990	April	Trailing hose	None	0	Shallow 24 hr	Pig	3.7	7.2	7.6	4.02	0.09	9.3

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
269-1990	1990	April	Trailing hose	None	0	Shallow 12 hr	Pig	3.7	7.2	7.6	4.02	0.09	8
270-1990	1990	April	Trailing hose	None	0	Shallow 6 hr	Pig	3.7	7.2	7.6	4.02	0.09	6.6
271-1990	1990	April	Trailing hose	None	0	Shallow 4 hr	Pig	3.7	7.2	7.6	4.02	0.09	5.9
050-1990	1990	April	Trailing hose	None	0	Deep 24 hr	Pig	3.7	7.2	7.6	4.02	0.09	7.8
051-1990	1990	April	Trailing hose	None	0	Deep 12 hr	Pig	3.7	7.2	7.6	4.02	0.09	6
052-1990	1990	April	Trailing hose	None	0	Deep 6 hr	Pig	3.7	7.2	7.6	4.02	0.09	4.1
053-1990	1990	April	Trailing hose	None	0	Deep 4 hr	Pig	3.7	7.2	7.6	4.02	0.09	3.2
092-1990	1990	April	Trailing hose	Winter cereal	25	None	Digestate	5.1	7.9	7.6	4.02	0.09	29
288-1990	1990	April	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	7.6	4.02	0.09	23
289-1990	1990	April	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	7.6	4.02	0.09	21
290-1990	1990	April	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	7.6	4.02	0.09	18
291-1990	1990	April	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	7.6	4.02	0.09	16
087-1990	1990	April	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	7.6	4.02	0.09	21
088-1990	1990	April	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	7.6	4.02	0.09	19
089-1990	1990	April	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	7.6	4.02	0.09	15
090-1990	1990	April	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	7.6	4.02	0.09	12
004-1990	1990	April	Open slot injection	Grass	10	Not relevant	Cattle	7	7	7.6	4.02	0.09	14
041-1990	1990	April	Open slot injection	Grass	10	Not relevant	Pig	3.7	7.2	7.6	4.02	0.09	9.7
078-1990	1990	April	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	7.6	4.02	0.09	17
002-1990	1990	April	Closed slot injection	None	0	Not relevant	Cattle	7	7	7.6	4.02	0.09	1.6
039-1990	1990	April	Closed slot injection	None	0	Not relevant	Pig	3.7	7.2	7.6	4.02	0.09	1.8
076-1990	1990	April	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	7.6	4.02	0.09	2.6
019-1990	1990	May	Trailing hose	Spring cereal	15	None	Cattle	7	7	11.7	3.45	0.09	31
056-1990	1990	May	Trailing hose	Spring cereal	15	None	Pig	3.7	7.2	11.7	3.45	0.09	15
093-1990	1990	May	Trailing hose	Spring cereal	15	None	Digestate	5.1	7.9	11.7	3.45	0.09	30

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
033-1990	1990	Spring-summer	Broadcast	Cereal and grass	15	None	Cattle	7	7	13.7	3.4	0.09	51
070-1990	1990	Spring-summer	Broadcast	Cereal and grass	15	None	Pig	3.7	7.2	13.7	3.4	0.09	32
107-1990	1990	Spring-summer	Broadcast	Cereal and grass	15	None	Digestate	5.1	7.9	13.7	3.4	0.09	50
020-1990	1990	Summer	Trailing hose	Grass	10	None	Cattle	7	7	16.4	3.18	0.09	35
252-1990	1990	Summer	Trailing hose	None	0	Shallow 24 hr	Cattle	7	7	16.4	3.18	0.09	30
253-1990	1990	Summer	Trailing hose	None	0	Shallow 12 hr	Cattle	7	7	16.4	3.18	0.09	25
254-1990	1990	Summer	Trailing hose	None	0	Shallow 6 hr	Cattle	7	7	16.4	3.18	0.09	20
255-1990	1990	Summer	Trailing hose	None	0	Shallow 4 hr	Cattle	7	7	16.4	3.18	0.09	17
021-1990	1990	Summer	Trailing hose	None	0	Deep 24 hr	Cattle	7	7	16.4	3.18	0.09	29
022-1990	1990	Summer	Trailing hose	None	0	Deep 12 hr	Cattle	7	7	16.4	3.18	0.09	22
023-1990	1990	Summer	Trailing hose	None	0	Deep 6 hr	Cattle	7	7	16.4	3.18	0.09	15
024-1990	1990	Summer	Trailing hose	None	0	Deep 4 hr	Cattle	7	7	16.4	3.18	0.09	11
057-1990	1990	Summer	Trailing hose	Grass	10	None	Pig	3.7	7.2	16.4	3.18	0.09	15
272-1990	1990	Summer	Trailing hose	None	0	Shallow 24 hr	Pig	3.7	7.2	16.4	3.18	0.09	10
273-1990	1990	Summer	Trailing hose	None	0	Shallow 12 hr	Pig	3.7	7.2	16.4	3.18	0.09	9.9
274-1990	1990	Summer	Trailing hose	None	0	Shallow 6 hr	Pig	3.7	7.2	16.4	3.18	0.09	9.1
275-1990	1990	Summer	Trailing hose	None	0	Shallow 4 hr	Pig	3.7	7.2	16.4	3.18	0.09	8.3
058-1990	1990	Summer	Trailing hose	None	0	Deep 24 hr	Pig	3.7	7.2	16.4	3.18	0.09	9
059-1990	1990	Summer	Trailing hose	None	0	Deep 12 hr	Pig	3.7	7.2	16.4	3.18	0.09	8.3
060-1990	1990	Summer	Trailing hose	None	0	Deep 6 hr	Pig	3.7	7.2	16.4	3.18	0.09	7.3
061-1990	1990	Summer	Trailing hose	None	0	Deep 4 hr	Pig	3.7	7.2	16.4	3.18	0.09	6.2
094-1990	1990	Summer	Trailing hose	Grass	10	None	Digestate	5.1	7.9	16.4	3.18	0.09	30
292-1990	1990	Summer	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	16.4	3.18	0.09	24
293-1990	1990	Summer	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	16.4	3.18	0.09	24
294-1990	1990	Summer	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	16.4	3.18	0.09	23
295-1990	1990	Summer	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	16.4	3.18	0.09	22
095-1990	1990	Summer	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	16.4	3.18	0.09	23
096-1990	1990	Summer	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	16.4	3.18	0.09	22
097-1990	1990	Summer	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	16.4	3.18	0.09	21
098-1990	1990	Summer	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	16.4	3.18	0.09	20

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
006-1990	1990	Summer, before winter rapeseed	Closed slot injection	None	0	Not relevant	Cattle	7	7	17.4	3.1	0.09	1.6
043-1990	1990	Summer, before winter rapeseed	Closed slot injection	None	0	Not relevant	Pig	3.7	7.2	17.4	3.1	0.09	1.8
080-1990	1990	Summer, before winter rapeseed	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	17.4	3.1	0.09	2.6
005-1990	1990	Summer, grass	Open slot injection	Grass	10	Not relevant	Cattle	7	7	15.3	3.25	0.09	16
042-1990	1990	Summer, grass	Open slot injection	Grass	10	Not relevant	Pig	3.7	7.2	15.3	3.25	0.09	9.9
079-1990	1990	Summer, grass	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	15.3	3.25	0.09	17
034-1990	1990	Late summer-autumn	Broadcast	Grass	10	None	Cattle	7	7	16.1	3.18	0.09	51
037-1990	1990	Late summer-autumn	Broadcast	None	0	None	Cattle	7	7	16.1	3.18	0.09	51
262-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Cattle	7	7	16.1	3.18	0.09	41
263-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Cattle	7	7	16.1	3.18	0.09	41
035-1990	1990	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Cattle	7	7	16.1	3.18	0.09	38

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
036-1990	1990	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Cattle	7	7	16.1	3.18	0.09	38
071-1990	1990	Late summer-autumn	Broadcast	Grass	10	None	Pig	3.7	7.2	16.1	3.18	0.09	32
074-1990	1990	Late summer-autumn	Broadcast	None	0	None	Pig	3.7	7.2	16.1	3.18	0.09	32
282-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Pig	3.7	7.2	16.1	3.18	0.09	16
283-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Pig	3.7	7.2	16.1	3.18	0.09	16
072-1990	1990	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Pig	3.7	7.2	16.1	3.18	0.09	11
073-1990	1990	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Pig	3.7	7.2	16.1	3.18	0.09	11
108-1990	1990	Late summer-autumn	Broadcast	Grass	10	None	Digestate	5.1	7.9	16.1	3.18	0.09	50
111-1990	1990	Late summer-autumn	Broadcast	None	0	None	Digestate	5.1	7.9	16.1	3.18	0.09	50
302-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Digestate	5.1	7.9	16.1	3.18	0.09	32
303-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Digestate	5.1	7.9	16.1	3.18	0.09	32

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
109-1990	1990	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Digestate	5.1	7.9	16.1	3.18	0.09	26
110-1990	1990	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Digestate	5.1	7.9	16.1	3.18	0.09	26
025-1990	1990	Autumn	Trailing hose	Grass	15	None	Cattle	7	7	13.7	3.33	0.09	33
256-1990	1990	Autumn	Trailing hose	None	0	Shallow 24 hr	Cattle	7	7	13.7	3.33	0.09	26
257-1990	1990	Autumn	Trailing hose	None	0	Shallow 12 hr	Cattle	7	7	13.7	3.33	0.09	21
258-1990	1990	Autumn	Trailing hose	None	0	Shallow 6 hr	Cattle	7	7	13.7	3.33	0.09	17
259-1990	1990	Autumn	Trailing hose	None	0	Shallow 4 hr	Cattle	7	7	13.7	3.33	0.09	15
026-1990	1990	Autumn	Trailing hose	None	0	Deep 24 hr	Cattle	7	7	13.7	3.33	0.09	24
027-1990	1990	Autumn	Trailing hose	None	0	Deep 12 hr	Cattle	7	7	13.7	3.33	0.09	17
028-1990	1990	Autumn	Trailing hose	None	0	Deep 6 hr	Cattle	7	7	13.7	3.33	0.09	11
029-1990	1990	Autumn	Trailing hose	None	0	Deep 4 hr	Cattle	7	7	13.7	3.33	0.09	8
062-1990	1990	Autumn	Trailing hose	Grass	15	None	Pig	3.7	7.2	13.7	3.33	0.09	15
276-1990	1990	Autumn	Trailing hose	None	0	Shallow 24 hr	Pig	3.7	7.2	13.7	3.33	0.09	10
277-1990	1990	Autumn	Trailing hose	None	0	Shallow 12 hr	Pig	3.7	7.2	13.7	3.33	0.09	9.4
278-1990	1990	Autumn	Trailing hose	None	0	Shallow 6 hr	Pig	3.7	7.2	13.7	3.33	0.09	8.3
279-1990	1990	Autumn	Trailing hose	None	0	Shallow 4 hr	Pig	3.7	7.2	13.7	3.33	0.09	7.4
063-1990	1990	Autumn	Trailing hose	None	0	Deep 24 hr	Pig	3.7	7.2	13.7	3.33	0.09	8.8
064-1990	1990	Autumn	Trailing hose	None	0	Deep 12 hr	Pig	3.7	7.2	13.7	3.33	0.09	7.8
065-1990	1990	Autumn	Trailing hose	None	0	Deep 6 hr	Pig	3.7	7.2	13.7	3.33	0.09	6.2
066-1990	1990	Autumn	Trailing hose	None	0	Deep 4 hr	Pig	3.7	7.2	13.7	3.33	0.09	5.1
099-1990	1990	Autumn	Trailing hose	Grass	15	None	Digestate	5.1	7.9	13.7	3.33	0.09	30
296-1990	1990	Autumn	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	13.7	3.33	0.09	24
297-1990	1990	Autumn	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	13.7	3.33	0.09	23
298-1990	1990	Autumn	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	13.7	3.33	0.09	22
299-1990	1990	Autumn	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	13.7	3.33	0.09	20
100-1990	1990	Autumn	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	13.7	3.33	0.09	22
101-1990	1990	Autumn	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	13.7	3.33	0.09	22
102-1990	1990	Autumn	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	13.7	3.33	0.09	20
103-1990	1990	Autumn	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	13.7	3.33	0.09	17
007-1990	1990	Autumn	Open slot injection	Grass	10	Not relevant	Cattle	7	7	13.7	3.33	0.09	16

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
044-1990	1990	Autumn	Open slot injection	Grass	10	Not relevant	Pig	3.7	7.2	13.7	3.33	0.09	9.8
081-1990	1990	Autumn	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	13.7	3.33	0.09	17
008-1990	1990	Autumn	Closed slot injection	None	0	Not relevant	Cattle	7	7	13.7	3.33	0.09	1.6
045-1990	1990	Autumn	Closed slot injection	None	0	Not relevant	Pig	3.7	7.2	13.7	3.33	0.09	1.8
082-1990	1990	Autumn	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	13.7	3.33	0.09	2.6
032-1990	1990	Winter-spring	Broadcast	None	0	None	Cattle	7	7	11.3	3.59	0.09	50
260-1990	1990	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Cattle	7	7	11.3	3.59	0.09	39
261-1990	1990	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Cattle	7	7	11.3	3.59	0.09	39
030-1990	1990	Winter-spring	Broadcast	None	0	Deep < 12 hr	Cattle	7	7	11.3	3.59	0.09	35
031-1990	1990	Winter-spring	Broadcast	None	0	Deep > 12 hr	Cattle	7	7	11.3	3.59	0.09	35
069-1990	1990	Winter-spring	Broadcast	None	0	None	Pig	3.7	7.2	11.3	3.59	0.09	32
280-1990	1990	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Pig	3.7	7.2	11.3	3.59	0.09	16
281-1990	1990	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Pig	3.7	7.2	11.3	3.59	0.09	16
067-1990	1990	Winter-spring	Broadcast	None	0	Deep < 12 hr	Pig	3.7	7.2	11.3	3.59	0.09	11
068-1990	1990	Winter-spring	Broadcast	None	0	Deep > 12 hr	Pig	3.7	7.2	11.3	3.59	0.09	11
106-1990	1990	Winter-spring	Broadcast	None	0	None	Digestate	5.1	7.9	11.3	3.59	0.09	50
300-1990	1990	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Digestate	5.1	7.9	11.3	3.59	0.09	32

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
301-1990	1990	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Digestate	5.1	7.9	11.3	3.59	0.09	32
104-1990	1990	Winter-spring	Broadcast	None	0	Deep < 12 hr	Digestate	5.1	7.9	11.3	3.59	0.09	25
105-1990	1990	Winter-spring	Broadcast	None	0	Deep > 12 hr	Digestate	5.1	7.9	11.3	3.59	0.09	25
017-1980	1980	March	Trailing hose	Winter cereal	15	None	Cattle	7.3	7	3.3	4.37	0.09	22
244-1980	1980	March	Trailing hose	None	0	Shallow 24 hr	Cattle	7.3	7	3.3	4.37	0.09	13
245-1980	1980	March	Trailing hose	None	0	Shallow 12 hr	Cattle	7.3	7	3.3	4.37	0.09	10
246-1980	1980	March	Trailing hose	None	0	Shallow 6 hr	Cattle	7.3	7	3.3	4.37	0.09	8.3
247-1980	1980	March	Trailing hose	None	0	Shallow 4 hr	Cattle	7.3	7	3.3	4.37	0.09	7.7
009-1980	1980	March	Trailing hose	None	0	Deep 24 hr	Cattle	7.3	7	3.3	4.37	0.09	9.5
010-1980	1980	March	Trailing hose	None	0	Deep 12 hr	Cattle	7.3	7	3.3	4.37	0.09	5.8
011-1980	1980	March	Trailing hose	None	0	Deep 6 hr	Cattle	7.3	7	3.3	4.37	0.09	3.5
012-1980	1980	March	Trailing hose	None	0	Deep 4 hr	Cattle	7.3	7	3.3	4.37	0.09	2.7
054-1980	1980	March	Trailing hose	Winter cereal	15	None	Pig	3.2	7.2	3.3	4.37	0.09	13
264-1980	1980	March	Trailing hose	None	0	Shallow 24 hr	Pig	3.2	7.2	3.3	4.37	0.09	7.5
265-1980	1980	March	Trailing hose	None	0	Shallow 12 hr	Pig	3.2	7.2	3.3	4.37	0.09	6.2
266-1980	1980	March	Trailing hose	None	0	Shallow 6 hr	Pig	3.2	7.2	3.3	4.37	0.09	5.2
267-1980	1980	March	Trailing hose	None	0	Shallow 4 hr	Pig	3.2	7.2	3.3	4.37	0.09	4.7
046-1980	1980	March	Trailing hose	None	0	Deep 24 hr	Pig	3.2	7.2	3.3	4.37	0.09	5.9
047-1980	1980	March	Trailing hose	None	0	Deep 12 hr	Pig	3.2	7.2	3.3	4.37	0.09	4.2
048-1980	1980	March	Trailing hose	None	0	Deep 6 hr	Pig	3.2	7.2	3.3	4.37	0.09	2.7
049-1980	1980	March	Trailing hose	None	0	Deep 4 hr	Pig	3.2	7.2	3.3	4.37	0.09	2.1
091-1980	1980	March	Trailing hose	Winter cereal	15	None	Digestate	5.1	7.9	3.3	4.37	0.09	28
284-1980	1980	March	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	3.3	4.37	0.09	21
285-1980	1980	March	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	3.3	4.37	0.09	18
286-1980	1980	March	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	3.3	4.37	0.09	15
287-1980	1980	March	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	3.3	4.37	0.09	13
083-1980	1980	March	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	3.3	4.37	0.09	19
084-1980	1980	March	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	3.3	4.37	0.09	15
085-1980	1980	March	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	3.3	4.37	0.09	10

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
086-1980	1980	March	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	3.3	4.37	0.09	7.8
003-1980	1980	March	Open slot injection	Grass	10	Not relevant	Cattle	7.3	7	3.3	4.37	0.09	12
040-1980	1980	March	Open slot injection	Grass	10	Not relevant	Pig	3.2	7.2	3.3	4.37	0.09	9.3
077-1980	1980	March	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	3.3	4.37	0.09	16
001-1980	1980	March	Closed slot injection	None	0	Not relevant	Cattle	7.3	7	3.3	4.37	0.09	1.6
038-1980	1980	March	Closed slot injection	None	0	Not relevant	Pig	3.2	7.2	3.3	4.37	0.09	1.8
075-1980	1980	March	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	3.3	4.37	0.09	2.6
018-1980	1980	April	Trailing hose	Winter cereal	25	None	Cattle	7.3	7	6.8	3.79	0.09	26
248-1980	1980	April	Trailing hose	None	0	Shallow 24 hr	Cattle	7.3	7	6.8	3.79	0.09	16
249-1980	1980	April	Trailing hose	None	0	Shallow 12 hr	Cattle	7.3	7	6.8	3.79	0.09	13
250-1980	1980	April	Trailing hose	None	0	Shallow 6 hr	Cattle	7.3	7	6.8	3.79	0.09	10
251-1980	1980	April	Trailing hose	None	0	Shallow 4 hr	Cattle	7.3	7	6.8	3.79	0.09	9.4
013-1980	1980	April	Trailing hose	None	0	Deep 24 hr	Cattle	7.3	7	6.8	3.79	0.09	13
014-1980	1980	April	Trailing hose	None	0	Deep 12 hr	Cattle	7.3	7	6.8	3.79	0.09	8
015-1980	1980	April	Trailing hose	None	0	Deep 6 hr	Cattle	7.3	7	6.8	3.79	0.09	4.8
016-1980	1980	April	Trailing hose	None	0	Deep 4 hr	Cattle	7.3	7	6.8	3.79	0.09	3.6
055-1980	1980	April	Trailing hose	Winter cereal	25	None	Pig	3.2	7.2	6.8	3.79	0.09	13
268-1980	1980	April	Trailing hose	None	0	Shallow 24 hr	Pig	3.2	7.2	6.8	3.79	0.09	8.1
269-1980	1980	April	Trailing hose	None	0	Shallow 12 hr	Pig	3.2	7.2	6.8	3.79	0.09	7
270-1980	1980	April	Trailing hose	None	0	Shallow 6 hr	Pig	3.2	7.2	6.8	3.79	0.09	5.8
271-1980	1980	April	Trailing hose	None	0	Shallow 4 hr	Pig	3.2	7.2	6.8	3.79	0.09	5.2
050-1980	1980	April	Trailing hose	None	0	Deep 24 hr	Pig	3.2	7.2	6.8	3.79	0.09	6.6
051-1980	1980	April	Trailing hose	None	0	Deep 12 hr	Pig	3.2	7.2	6.8	3.79	0.09	5
052-1980	1980	April	Trailing hose	None	0	Deep 6 hr	Pig	3.2	7.2	6.8	3.79	0.09	3.4
053-1980	1980	April	Trailing hose	None	0	Deep 4 hr	Pig	3.2	7.2	6.8	3.79	0.09	2.7
092-1980	1980	April	Trailing hose	Winter cereal	25	None	Digestate	5.1	7.9	6.8	3.79	0.09	29

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
288-1980	1980	April	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	6.8	3.79	0.09	22
289-1980	1980	April	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	6.8	3.79	0.09	20
290-1980	1980	April	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	6.8	3.79	0.09	17
291-1980	1980	April	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	6.8	3.79	0.09	15
087-1980	1980	April	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	6.8	3.79	0.09	21
088-1980	1980	April	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	6.8	3.79	0.09	18
089-1980	1980	April	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	6.8	3.79	0.09	13
090-1980	1980	April	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	6.8	3.79	0.09	10
004-1980	1980	April	Open slot injection	Grass	10	Not relevant	Cattle	7.3	7	6.8	3.79	0.09	14
041-1980	1980	April	Open slot injection	Grass	10	Not relevant	Pig	3.2	7.2	6.8	3.79	0.09	9.4
078-1980	1980	April	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	6.8	3.79	0.09	17
002-1980	1980	April	Closed slot injection	None	0	Not relevant	Cattle	7.3	7	6.8	3.79	0.09	1.6
039-1980	1980	April	Closed slot injection	None	0	Not relevant	Pig	3.2	7.2	6.8	3.79	0.09	1.8
076-1980	1980	April	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	6.8	3.79	0.09	2.6
019-1980	1980	May	Trailing hose	Spring cereal	15	None	Cattle	7.3	7	12	3.68	0.09	33
056-1980	1980	May	Trailing hose	Spring cereal	15	None	Pig	3.2	7.2	12	3.68	0.09	14
093-1980	1980	May	Trailing hose	Spring cereal	15	None	Digestate	5.1	7.9	12	3.68	0.09	30
033-1980	1980	Spring-summer	Broadcast	Cereal and grass	15	None	Cattle	7.3	7	13.1	3.4	0.09	52
070-1980	1980	Spring-summer	Broadcast	Cereal and grass	15	None	Pig	3.2	7.2	13.1	3.4	0.09	31
107-1980	1980	Spring-summer	Broadcast	Cereal and grass	15	None	Digestate	5.1	7.9	13.1	3.4	0.09	50
020-1980	1980	Summer	Trailing hose	Grass	10	None	Cattle	7.3	7	15.6	3.18	0.09	36
252-1980	1980	Summer	Trailing hose	None	0	Shallow 24 hr	Cattle	7.3	7	15.6	3.18	0.09	30
253-1980	1980	Summer	Trailing hose	None	0	Shallow 12 hr	Cattle	7.3	7	15.6	3.18	0.09	25

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed ($m\ s^{-1}$)	Rainfall rate ($mm\ h^{-1}$)	Emission factor (%)
254-1980	1980	Summer	Trailing hose	None	0	Shallow 6 hr	Cattle	7.3	7	15.6	3.18	0.09	19
255-1980	1980	Summer	Trailing hose	None	0	Shallow 4 hr	Cattle	7.3	7	15.6	3.18	0.09	17
021-1980	1980	Summer	Trailing hose	None	0	Deep 24 hr	Cattle	7.3	7	15.6	3.18	0.09	28
022-1980	1980	Summer	Trailing hose	None	0	Deep 12 hr	Cattle	7.3	7	15.6	3.18	0.09	20
023-1980	1980	Summer	Trailing hose	None	0	Deep 6 hr	Cattle	7.3	7	15.6	3.18	0.09	13
024-1980	1980	Summer	Trailing hose	None	0	Deep 4 hr	Cattle	7.3	7	15.6	3.18	0.09	9.8
057-1980	1980	Summer	Trailing hose	Grass	10	None	Pig	3.2	7.2	15.6	3.18	0.09	14
272-1980	1980	Summer	Trailing hose	None	0	Shallow 24 hr	Pig	3.2	7.2	15.6	3.18	0.09	9.1
273-1980	1980	Summer	Trailing hose	None	0	Shallow 12 hr	Pig	3.2	7.2	15.6	3.18	0.09	8.6
274-1980	1980	Summer	Trailing hose	None	0	Shallow 6 hr	Pig	3.2	7.2	15.6	3.18	0.09	8
275-1980	1980	Summer	Trailing hose	None	0	Shallow 4 hr	Pig	3.2	7.2	15.6	3.18	0.09	7.3
058-1980	1980	Summer	Trailing hose	None	0	Deep 24 hr	Pig	3.2	7.2	15.6	3.18	0.09	7.7
059-1980	1980	Summer	Trailing hose	None	0	Deep 12 hr	Pig	3.2	7.2	15.6	3.18	0.09	7.1
060-1980	1980	Summer	Trailing hose	None	0	Deep 6 hr	Pig	3.2	7.2	15.6	3.18	0.09	6.2
061-1980	1980	Summer	Trailing hose	None	0	Deep 4 hr	Pig	3.2	7.2	15.6	3.18	0.09	5.3
094-1980	1980	Summer	Trailing hose	Grass	10	None	Digestate	5.1	7.9	15.6	3.18	0.09	30
292-1980	1980	Summer	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	15.6	3.18	0.09	24
293-1980	1980	Summer	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	15.6	3.18	0.09	24
294-1980	1980	Summer	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	15.6	3.18	0.09	23
295-1980	1980	Summer	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	15.6	3.18	0.09	22
095-1980	1980	Summer	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	15.6	3.18	0.09	23
096-1980	1980	Summer	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	15.6	3.18	0.09	22
097-1980	1980	Summer	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	15.6	3.18	0.09	21
098-1980	1980	Summer	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	15.6	3.18	0.09	19
006-1980	1980	Summer, before winter rapeseed	Closed slot injection	None	0	Not relevant	Cattle	7.3	7	16	3.39	0.09	1.6
043-1980	1980	Summer, before winter rapeseed	Closed slot injection	None	0	Not relevant	Pig	3.2	7.2	16	3.39	0.09	1.8

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
080-1980	1980	Summer, before winter rapeseed	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	16	3.39	0.09	2.6
005-1980	1980	Summer, grass	Open slot injection	Grass	10	Not relevant	Cattle	7.3	7	14.7	3.31	0.09	17
042-1980	1980	Summer, grass	Open slot injection	Grass	10	Not relevant	Pig	3.2	7.2	14.7	3.31	0.09	9.6
079-1980	1980	Summer, grass	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	14.7	3.31	0.09	17
034-1980	1980	Late summer-autumn	Broadcast	Grass	10	None	Cattle	7.3	7	15.2	3.41	0.09	53
037-1980	1980	Late summer-autumn	Broadcast	None	0	None	Cattle	7.3	7	15.2	3.41	0.09	53
262-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Cattle	7.3	7	15.2	3.41	0.09	43
263-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Cattle	7.3	7	15.2	3.41	0.09	43
035-1980	1980	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Cattle	7.3	7	15.2	3.41	0.09	40
036-1980	1980	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Cattle	7.3	7	15.2	3.41	0.09	40
071-1980	1980	Late summer-autumn	Broadcast	Grass	10	None	Pig	3.2	7.2	15.2	3.41	0.09	31
074-1980	1980	Late summer-autumn	Broadcast	None	0	None	Pig	3.2	7.2	15.2	3.41	0.09	31

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
282-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Pig	3.2	7.2	15.2	3.41	0.09	15
283-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Pig	3.2	7.2	15.2	3.41	0.09	15
072-1980	1980	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Pig	3.2	7.2	15.2	3.41	0.09	10
073-1980	1980	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Pig	3.2	7.2	15.2	3.41	0.09	10
108-1980	1980	Late summer-autumn	Broadcast	Grass	10	None	Digestate	5.1	7.9	15.2	3.41	0.09	50
111-1980	1980	Late summer-autumn	Broadcast	None	0	None	Digestate	5.1	7.9	15.2	3.41	0.09	50
302-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Digestate	5.1	7.9	15.2	3.41	0.09	32
303-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Digestate	5.1	7.9	15.2	3.41	0.09	32
109-1980	1980	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Digestate	5.1	7.9	15.2	3.41	0.09	26
110-1980	1980	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Digestate	5.1	7.9	15.2	3.41	0.09	26
025-1980	1980	Autumn	Trailing hose	Grass	15	None	Cattle	7.3	7	13.6	3.45	0.09	35
256-1980	1980	Autumn	Trailing hose	None	0	Shallow 24 hr	Cattle	7.3	7	13.6	3.45	0.09	27
257-1980	1980	Autumn	Trailing hose	None	0	Shallow 12 hr	Cattle	7.3	7	13.6	3.45	0.09	22
258-1980	1980	Autumn	Trailing hose	None	0	Shallow 6 hr	Cattle	7.3	7	13.6	3.45	0.09	17
259-1980	1980	Autumn	Trailing hose	None	0	Shallow 4 hr	Cattle	7.3	7	13.6	3.45	0.09	15

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
026-1980	1980	Autumn	Trailing hose	None	0	Deep 24 hr	Cattle	7.3	7	13.6	3.45	0.09	25
027-1980	1980	Autumn	Trailing hose	None	0	Deep 12 hr	Cattle	7.3	7	13.6	3.45	0.09	17
028-1980	1980	Autumn	Trailing hose	None	0	Deep 6 hr	Cattle	7.3	7	13.6	3.45	0.09	11
029-1980	1980	Autumn	Trailing hose	None	0	Deep 4 hr	Cattle	7.3	7	13.6	3.45	0.09	8
062-1980	1980	Autumn	Trailing hose	Grass	15	None	Pig	3.2	7.2	13.6	3.45	0.09	14
276-1980	1980	Autumn	Trailing hose	None	0	Shallow 24 hr	Pig	3.2	7.2	13.6	3.45	0.09	9
277-1980	1980	Autumn	Trailing hose	None	0	Shallow 12 hr	Pig	3.2	7.2	13.6	3.45	0.09	8.5
278-1980	1980	Autumn	Trailing hose	None	0	Shallow 6 hr	Pig	3.2	7.2	13.6	3.45	0.09	7.6
279-1980	1980	Autumn	Trailing hose	None	0	Shallow 4 hr	Pig	3.2	7.2	13.6	3.45	0.09	6.9
063-1980	1980	Autumn	Trailing hose	None	0	Deep 24 hr	Pig	3.2	7.2	13.6	3.45	0.09	7.7
064-1980	1980	Autumn	Trailing hose	None	0	Deep 12 hr	Pig	3.2	7.2	13.6	3.45	0.09	6.9
065-1980	1980	Autumn	Trailing hose	None	0	Deep 6 hr	Pig	3.2	7.2	13.6	3.45	0.09	5.7
066-1980	1980	Autumn	Trailing hose	None	0	Deep 4 hr	Pig	3.2	7.2	13.6	3.45	0.09	4.8
099-1980	1980	Autumn	Trailing hose	Grass	15	None	Digestate	5.1	7.9	13.6	3.45	0.09	30
296-1980	1980	Autumn	Trailing hose	None	0	Shallow 24 hr	Digestate	5.1	7.9	13.6	3.45	0.09	24
297-1980	1980	Autumn	Trailing hose	None	0	Shallow 12 hr	Digestate	5.1	7.9	13.6	3.45	0.09	23
298-1980	1980	Autumn	Trailing hose	None	0	Shallow 6 hr	Digestate	5.1	7.9	13.6	3.45	0.09	22
299-1980	1980	Autumn	Trailing hose	None	0	Shallow 4 hr	Digestate	5.1	7.9	13.6	3.45	0.09	21
100-1980	1980	Autumn	Trailing hose	None	0	Deep 24 hr	Digestate	5.1	7.9	13.6	3.45	0.09	22
101-1980	1980	Autumn	Trailing hose	None	0	Deep 12 hr	Digestate	5.1	7.9	13.6	3.45	0.09	22
102-1980	1980	Autumn	Trailing hose	None	0	Deep 6 hr	Digestate	5.1	7.9	13.6	3.45	0.09	20
103-1980	1980	Autumn	Trailing hose	None	0	Deep 4 hr	Digestate	5.1	7.9	13.6	3.45	0.09	18
007-1980	1980	Autumn	Open slot injection	Grass	10	Not relevant	Cattle	7.3	7	13.6	3.45	0.09	17
044-1980	1980	Autumn	Open slot injection	Grass	10	Not relevant	Pig	3.2	7.2	13.6	3.45	0.09	9.5
081-1980	1980	Autumn	Open slot injection	Grass	10	Not relevant	Digestate	5.1	7.9	13.6	3.45	0.09	17
008-1980	1980	Autumn	Closed slot injection	None	0	Not relevant	Cattle	7.3	7	13.6	3.45	0.09	1.6
045-1980	1980	Autumn	Closed slot injection	None	0	Not relevant	Pig	3.2	7.2	13.6	3.45	0.09	1.8
082-1980	1980	Autumn	Closed slot injection	None	0	Not relevant	Digestate	5.1	7.9	13.6	3.45	0.09	2.6

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed ($m\ s^{-1}$)	Rainfall rate ($mm\ h^{-1}$)	Emission factor (%)
032-1980	1980	Winter-spring	Broadcast	None	0	None	Cattle	7.3	7	10.9	3.6	0.09	52
260-1980	1980	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Cattle	7.3	7	10.9	3.6	0.09	40
261-1980	1980	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Cattle	7.3	7	10.9	3.6	0.09	40
030-1980	1980	Winter-spring	Broadcast	None	0	Deep < 12 hr	Cattle	7.3	7	10.9	3.6	0.09	36
031-1980	1980	Winter-spring	Broadcast	None	0	Deep > 12 hr	Cattle	7.3	7	10.9	3.6	0.09	36
069-1980	1980	Winter-spring	Broadcast	None	0	None	Pig	3.2	7.2	10.9	3.6	0.09	31
280-1980	1980	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Pig	3.2	7.2	10.9	3.6	0.09	15
281-1980	1980	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Pig	3.2	7.2	10.9	3.6	0.09	15
067-1980	1980	Winter-spring	Broadcast	None	0	Deep < 12 hr	Pig	3.2	7.2	10.9	3.6	0.09	9.9
068-1980	1980	Winter-spring	Broadcast	None	0	Deep > 12 hr	Pig	3.2	7.2	10.9	3.6	0.09	9.9
106-1980	1980	Winter-spring	Broadcast	None	0	None	Digestate	5.1	7.9	10.9	3.6	0.09	50
300-1980	1980	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Digestate	5.1	7.9	10.9	3.6	0.09	32
301-1980	1980	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Digestate	5.1	7.9	10.9	3.6	0.09	32
104-1980	1980	Winter-spring	Broadcast	None	0	Deep < 12 hr	Digestate	5.1	7.9	10.9	3.6	0.09	25
105-1980	1980	Winter-spring	Broadcast	None	0	Deep > 12 hr	Digestate	5.1	7.9	10.9	3.6	0.09	25

Table A1.2. New emission factors for barn acidified manure as percentage of applied TAN. Decade column gives the start of each period (e.g., 1980 refers to 1980-1989). Air temperature and wind speed values presented here are adjusted (Section 3.3).

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
120-2010	2010	March	Trailing hose	Winter cereal	15	None	Cattle	6.5	6	4.9	4.02	0.09	9.6
133-2010	2010	March	Trailing hose	None	0	None	Cattle	6.5	6	4.9	4.02	0.09	9.6
304-2010	2010	March	Trailing hose	None	0	Shallow 24 hr	Cattle	6.5	6	4.9	4.02	0.09	4.7
305-2010	2010	March	Trailing hose	None	0	Shallow 12 hr	Cattle	6.5	6	4.9	4.02	0.09	3.8
306-2010	2010	March	Trailing hose	None	0	Shallow 6 hr	Cattle	6.5	6	4.9	4.02	0.09	3.3
307-2010	2010	March	Trailing hose	None	0	Shallow 4 hr	Cattle	6.5	6	4.9	4.02	0.09	3.1
112-2010	2010	March	Trailing hose	None	0	Deep 24 hr	Cattle	6.5	6	4.9	4.02	0.09	3.1
113-2010	2010	March	Trailing hose	None	0	Deep 12 hr	Cattle	6.5	6	4.9	4.02	0.09	1.9
114-2010	2010	March	Trailing hose	None	0	Deep 6 hr	Cattle	6.5	6	4.9	4.02	0.09	1.2
115-2010	2010	March	Trailing hose	None	0	Deep 4 hr	Cattle	6.5	6	4.9	4.02	0.09	0.92
153-2010	2010	March	Trailing hose	Winter cereal	15	None	Pig	3.9	6	4.9	4.02	0.09	7
166-2010	2010	March	Trailing hose	None	0	None	Pig	3.9	6	4.9	4.02	0.09	7
324-2010	2010	March	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6	4.9	4.02	0.09	3.3
325-2010	2010	March	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6	4.9	4.02	0.09	2.7
326-2010	2010	March	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6	4.9	4.02	0.09	2.3
327-2010	2010	March	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6	4.9	4.02	0.09	2.2
145-2010	2010	March	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6	4.9	4.02	0.09	2.2
146-2010	2010	March	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6	4.9	4.02	0.09	1.4

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
147-2010	2010	March	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6	4.9	4.02	0.09	0.86
148-2010	2010	March	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6	4.9	4.02	0.09	0.68
121-2010	2010	April	Trailing hose	Winter cereal	25	None	Cattle	6.5	6	8.5	3.91	0.09	13
134-2010	2010	April	Trailing hose	None	0	None	Cattle	6.5	6	8.5	3.91	0.09	13
308-2010	2010	April	Trailing hose	None	0	Shallow 24 hr	Cattle	6.5	6	8.5	3.91	0.09	6.9
309-2010	2010	April	Trailing hose	None	0	Shallow 12 hr	Cattle	6.5	6	8.5	3.91	0.09	5.4
310-2010	2010	April	Trailing hose	None	0	Shallow 6 hr	Cattle	6.5	6	8.5	3.91	0.09	4.6
311-2010	2010	April	Trailing hose	None	0	Shallow 4 hr	Cattle	6.5	6	8.5	3.91	0.09	4.3
116-2010	2010	April	Trailing hose	None	0	Deep 24 hr	Cattle	6.5	6	8.5	3.91	0.09	4.9
117-2010	2010	April	Trailing hose	None	0	Deep 12 hr	Cattle	6.5	6	8.5	3.91	0.09	2.9
118-2010	2010	April	Trailing hose	None	0	Deep 6 hr	Cattle	6.5	6	8.5	3.91	0.09	1.8
119-2010	2010	April	Trailing hose	None	0	Deep 4 hr	Cattle	6.5	6	8.5	3.91	0.09	1.4
154-2010	2010	April	Trailing hose	Winter cereal	25	None	Pig	3.9	6	8.5	3.91	0.09	8.2
167-2010	2010	April	Trailing hose	None	0	None	Pig	3.9	6	8.5	3.91	0.09	8.2
328-2010	2010	April	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6	8.5	3.91	0.09	4.3
329-2010	2010	April	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6	8.5	3.91	0.09	3.4
330-2010	2010	April	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6	8.5	3.91	0.09	2.9
331-2010	2010	April	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6	8.5	3.91	0.09	2.7
149-2010	2010	April	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6	8.5	3.91	0.09	3.1

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
150-2010	2010	April	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6	8.5	3.91	0.09	1.9
151-2010	2010	April	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6	8.5	3.91	0.09	1.2
152-2010	2010	April	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6	8.5	3.91	0.09	0.93
122-2010	2010	May	Trailing hose	Spring cereal	15	None	Cattle	6.5	6	12.4	3.56	0.09	17
155-2010	2010	May	Trailing hose	Spring cereal	15	None	Pig	3.9	6	12.4	3.56	0.09	9.3
140-2010	2010	Spring-summer	Broadcast	Cereal and grass	15	None	Cattle	6.5	6	14.3	3.4	0.09	38
173-2010	2010	Spring-summer	Broadcast	Cereal and grass	15	None	Pig	3.9	6	14.3	3.4	0.09	21
123-2010	2010	Summer	Trailing hose	Grass	10	None	Cattle	6.5	6	16.9	3.18	0.09	22
135-2010	2010	Summer	Trailing hose	None	0	None	Cattle	6.5	6	16.9	3.18	0.09	22
312-2010	2010	Summer	Trailing hose	None	0	Shallow 24 hr	Cattle	6.5	6	16.9	3.18	0.09	14
313-2010	2010	Summer	Trailing hose	None	0	Shallow 12 hr	Cattle	6.5	6	16.9	3.18	0.09	11
314-2010	2010	Summer	Trailing hose	None	0	Shallow 6 hr	Cattle	6.5	6	16.9	3.18	0.09	8.9
315-2010	2010	Summer	Trailing hose	None	0	Shallow 4 hr	Cattle	6.5	6	16.9	3.18	0.09	8.1
124-2010	2010	Summer	Trailing hose	None	0	Deep 24 hr	Cattle	6.5	6	16.9	3.18	0.09	12
125-2010	2010	Summer	Trailing hose	None	0	Deep 12 hr	Cattle	6.5	6	16.9	3.18	0.09	7.6
126-2010	2010	Summer	Trailing hose	None	0	Deep 6 hr	Cattle	6.5	6	16.9	3.18	0.09	4.5
127-2010	2010	Summer	Trailing hose	None	0	Deep 4 hr	Cattle	6.5	6	16.9	3.18	0.09	3.3
156-2010	2010	Summer	Trailing hose	Grass	10	None	Pig	3.9	6	16.9	3.18	0.09	10
168-2010	2010	Summer	Trailing hose	None	0	None	Pig	3.9	6	16.9	3.18	0.09	10

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
332-2010	2010	Summer	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6	16.9	3.18	0.09	7
333-2010	2010	Summer	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6	16.9	3.18	0.09	5.7
334-2010	2010	Summer	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6	16.9	3.18	0.09	4.5
335-2010	2010	Summer	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6	16.9	3.18	0.09	4.1
157-2010	2010	Summer	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6	16.9	3.18	0.09	6
158-2010	2010	Summer	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6	16.9	3.18	0.09	4.2
159-2010	2010	Summer	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6	16.9	3.18	0.09	2.6
160-2010	2010	Summer	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6	16.9	3.18	0.09	2
141-2010	2010	Late summer-autumn	Broadcast	Grass	10	None	Cattle	6.5	6	16.6	3.22	0.09	39
144-2010	2010	Late summer-autumn	Broadcast	None	0	None	Cattle	6.5	6	16.6	3.22	0.09	39
322-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Cattle	6.5	6	16.6	3.22	0.09	29
323-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Cattle	6.5	6	16.6	3.22	0.09	29
142-2010	2010	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Cattle	6.5	6	16.6	3.22	0.09	25
143-2010	2010	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Cattle	6.5	6	16.6	3.22	0.09	25
174-2010	2010	Late summer-autumn	Broadcast	Grass	10	None	Pig	3.9	6	16.6	3.22	0.09	22

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
177-2010	2010	Late summer-autumn	Broadcast	None	0	None	Pig	3.9	6	16.6	3.22	0.09	22
342-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Pig	3.9	6	16.6	3.22	0.09	12
343-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Pig	3.9	6	16.6	3.22	0.09	12
175-2010	2010	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Pig	3.9	6	16.6	3.22	0.09	9.7
176-2010	2010	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Pig	3.9	6	16.6	3.22	0.09	9.7
128-2010	2010	Autumn	Trailing hose	Grass	15	None	Cattle	6.5	6	14.6	3.45	0.09	19
136-2010	2010	Autumn	Trailing hose	None	0	None	Cattle	6.5	6	14.6	3.45	0.09	19
316-2010	2010	Autumn	Trailing hose	None	0	Shallow 24 hr	Cattle	6.5	6	14.6	3.45	0.09	12
317-2010	2010	Autumn	Trailing hose	None	0	Shallow 12 hr	Cattle	6.5	6	14.6	3.45	0.09	9.4
318-2010	2010	Autumn	Trailing hose	None	0	Shallow 6 hr	Cattle	6.5	6	14.6	3.45	0.09	7.6
319-2010	2010	Autumn	Trailing hose	None	0	Shallow 4 hr	Cattle	6.5	6	14.6	3.45	0.09	7
129-2010	2010	Autumn	Trailing hose	None	0	Deep 24 hr	Cattle	6.5	6	14.6	3.45	0.09	9.7
130-2010	2010	Autumn	Trailing hose	None	0	Deep 12 hr	Cattle	6.5	6	14.6	3.45	0.09	6
131-2010	2010	Autumn	Trailing hose	None	0	Deep 6 hr	Cattle	6.5	6	14.6	3.45	0.09	3.6
132-2010	2010	Autumn	Trailing hose	None	0	Deep 4 hr	Cattle	6.5	6	14.6	3.45	0.09	2.7
161-2010	2010	Autumn	Trailing hose	Grass	15	None	Pig	3.9	6	14.6	3.45	0.09	9.9

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
169-2010	2010	Autumn	Trailing hose	None	0	None	Pig	3.9	6	14.6	3.45	0.09	9.9
336-2010	2010	Autumn	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6	14.6	3.45	0.09	6.3
337-2010	2010	Autumn	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6	14.6	3.45	0.09	5
338-2010	2010	Autumn	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6	14.6	3.45	0.09	4.1
339-2010	2010	Autumn	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6	14.6	3.45	0.09	3.7
162-2010	2010	Autumn	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6	14.6	3.45	0.09	5.2
163-2010	2010	Autumn	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6	14.6	3.45	0.09	3.5
164-2010	2010	Autumn	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6	14.6	3.45	0.09	2.2
165-2010	2010	Autumn	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6	14.6	3.45	0.09	1.6
139-2010	2010	Winter-spring	Broadcast	None	0	None	Cattle	6.5	6	12	3.53	0.09	37
320-2010	2010	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Cattle	6.5	6	12	3.53	0.09	23
321-2010	2010	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Cattle	6.5	6	12	3.53	0.09	23
137-2010	2010	Winter-spring	Broadcast	None	0	Deep < 12 hr	Cattle	6.5	6	12	3.53	0.09	18
138-2010	2010	Winter-spring	Broadcast	None	0	Deep > 12 hr	Cattle	6.5	6	12	3.53	0.09	18
172-2010	2010	Winter-spring	Broadcast	None	0	None	Pig	3.9	6	12	3.53	0.09	21
340-2010	2010	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Pig	3.9	6	12	3.53	0.09	12
341-2010	2010	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Pig	3.9	6	12	3.53	0.09	12
170-2010	2010	Winter-spring	Broadcast	None	0	Deep < 12 hr	Pig	3.9	6	12	3.53	0.09	8.6

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
171-2010	2010	Winter-spring	Broadcast	None	0	Deep > 12 hr	Pig	3.9	6	12	3.53	0.09	8.6
120-2000	2000	March	Trailing hose	Winter cereal	15	None	Cattle	6.4	6	4	4.02	0.09	8.9
133-2000	2000	March	Trailing hose	None	0	None	Cattle	6.4	6	4	4.02	0.09	8.9
304-2000	2000	March	Trailing hose	None	0	Shallow 24 hr	Cattle	6.4	6	4	4.02	0.09	4.3
305-2000	2000	March	Trailing hose	None	0	Shallow 12 hr	Cattle	6.4	6	4	4.02	0.09	3.5
306-2000	2000	March	Trailing hose	None	0	Shallow 6 hr	Cattle	6.4	6	4	4.02	0.09	3
307-2000	2000	March	Trailing hose	None	0	Shallow 4 hr	Cattle	6.4	6	4	4.02	0.09	2.9
112-2000	2000	March	Trailing hose	None	0	Deep 24 hr	Cattle	6.4	6	4	4.02	0.09	2.8
113-2000	2000	March	Trailing hose	None	0	Deep 12 hr	Cattle	6.4	6	4	4.02	0.09	1.7
114-2000	2000	March	Trailing hose	None	0	Deep 6 hr	Cattle	6.4	6	4	4.02	0.09	1.1
115-2000	2000	March	Trailing hose	None	0	Deep 4 hr	Cattle	6.4	6	4	4.02	0.09	0.84
153-2000	2000	March	Trailing hose	Winter cereal	15	None	Pig	3.9	6	4	4.02	0.09	6.7
166-2000	2000	March	Trailing hose	None	0	None	Pig	3.9	6	4	4.02	0.09	6.7
324-2000	2000	March	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6	4	4.02	0.09	3.1
325-2000	2000	March	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6	4	4.02	0.09	2.6
326-2000	2000	March	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6	4	4.02	0.09	2.2
327-2000	2000	March	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6	4	4.02	0.09	2.1
145-2000	2000	March	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6	4	4.02	0.09	2
146-2000	2000	March	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6	4	4.02	0.09	1.2

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
147-2000	2000	March	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6	4	4.02	0.09	0.8
148-2000	2000	March	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6	4	4.02	0.09	0.64
121-2000	2000	April	Trailing hose	Winter cereal	25	None	Cattle	6.4	6	8.5	3.45	0.09	12
134-2000	2000	April	Trailing hose	None	0	None	Cattle	6.4	6	8.5	3.45	0.09	12
308-2000	2000	April	Trailing hose	None	0	Shallow 24 hr	Cattle	6.4	6	8.5	3.45	0.09	6.2
309-2000	2000	April	Trailing hose	None	0	Shallow 12 hr	Cattle	6.4	6	8.5	3.45	0.09	4.9
310-2000	2000	April	Trailing hose	None	0	Shallow 6 hr	Cattle	6.4	6	8.5	3.45	0.09	4.2
311-2000	2000	April	Trailing hose	None	0	Shallow 4 hr	Cattle	6.4	6	8.5	3.45	0.09	3.9
116-2000	2000	April	Trailing hose	None	0	Deep 24 hr	Cattle	6.4	6	8.5	3.45	0.09	4.3
117-2000	2000	April	Trailing hose	None	0	Deep 12 hr	Cattle	6.4	6	8.5	3.45	0.09	2.6
118-2000	2000	April	Trailing hose	None	0	Deep 6 hr	Cattle	6.4	6	8.5	3.45	0.09	1.6
119-2000	2000	April	Trailing hose	None	0	Deep 4 hr	Cattle	6.4	6	8.5	3.45	0.09	1.2
154-2000	2000	April	Trailing hose	Winter cereal	25	None	Pig	3.9	6	8.5	3.45	0.09	7.8
167-2000	2000	April	Trailing hose	None	0	None	Pig	3.9	6	8.5	3.45	0.09	7.8
328-2000	2000	April	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6	8.5	3.45	0.09	4
329-2000	2000	April	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6	8.5	3.45	0.09	3.2
330-2000	2000	April	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6	8.5	3.45	0.09	2.7
331-2000	2000	April	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6	8.5	3.45	0.09	2.5
149-2000	2000	April	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6	8.5	3.45	0.09	2.8

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
150-2000	2000	April	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6	8.5	3.45	0.09	1.7
151-2000	2000	April	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6	8.5	3.45	0.09	1.1
152-2000	2000	April	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6	8.5	3.45	0.09	0.85
122-2000	2000	May	Trailing hose	Spring cereal	15	None	Cattle	6.4	6	12.5	3.33	0.09	16
155-2000	2000	May	Trailing hose	Spring cereal	15	None	Pig	3.9	6	12.5	3.33	0.09	9.2
140-2000	2000	Spring-summer	Broadcast	Cereal and grass	15	None	Cattle	6.4	6	14.3	3.22	0.09	37
173-2000	2000	Spring-summer	Broadcast	Cereal and grass	15	None	Pig	3.9	6	14.3	3.22	0.09	21
123-2000	2000	Summer	Trailing hose	Grass	10	None	Cattle	6.4	6	16.9	3.1	0.09	21
135-2000	2000	Summer	Trailing hose	None	0	None	Cattle	6.4	6	16.9	3.1	0.09	21
312-2000	2000	Summer	Trailing hose	None	0	Shallow 24 hr	Cattle	6.4	6	16.9	3.1	0.09	14
313-2000	2000	Summer	Trailing hose	None	0	Shallow 12 hr	Cattle	6.4	6	16.9	3.1	0.09	11
314-2000	2000	Summer	Trailing hose	None	0	Shallow 6 hr	Cattle	6.4	6	16.9	3.1	0.09	8.8
315-2000	2000	Summer	Trailing hose	None	0	Shallow 4 hr	Cattle	6.4	6	16.9	3.1	0.09	7.9
124-2000	2000	Summer	Trailing hose	None	0	Deep 24 hr	Cattle	6.4	6	16.9	3.1	0.09	12
125-2000	2000	Summer	Trailing hose	None	0	Deep 12 hr	Cattle	6.4	6	16.9	3.1	0.09	7.5
126-2000	2000	Summer	Trailing hose	None	0	Deep 6 hr	Cattle	6.4	6	16.9	3.1	0.09	4.5
127-2000	2000	Summer	Trailing hose	None	0	Deep 4 hr	Cattle	6.4	6	16.9	3.1	0.09	3.3
156-2000	2000	Summer	Trailing hose	Grass	10	None	Pig	3.9	6	16.9	3.1	0.09	10
168-2000	2000	Summer	Trailing hose	None	0	None	Pig	3.9	6	16.9	3.1	0.09	10

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
332-2000	2000	Summer	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6	16.9	3.1	0.09	7
333-2000	2000	Summer	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6	16.9	3.1	0.09	5.6
334-2000	2000	Summer	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6	16.9	3.1	0.09	4.5
335-2000	2000	Summer	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6	16.9	3.1	0.09	4
157-2000	2000	Summer	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6	16.9	3.1	0.09	5.9
158-2000	2000	Summer	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6	16.9	3.1	0.09	4.1
159-2000	2000	Summer	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6	16.9	3.1	0.09	2.6
160-2000	2000	Summer	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6	16.9	3.1	0.09	2
141-2000	2000	Late summer-autumn	Broadcast	Grass	10	None	Cattle	6.4	6	16.7	3.1	0.09	38
144-2000	2000	Late summer-autumn	Broadcast	None	0	None	Cattle	6.4	6	16.7	3.1	0.09	38
322-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Cattle	6.4	6	16.7	3.1	0.09	28
323-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Cattle	6.4	6	16.7	3.1	0.09	28
142-2000	2000	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Cattle	6.4	6	16.7	3.1	0.09	25
143-2000	2000	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Cattle	6.4	6	16.7	3.1	0.09	25
174-2000	2000	Late summer-autumn	Broadcast	Grass	10	None	Pig	3.9	6	16.7	3.1	0.09	22

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
177-2000	2000	Late summer-autumn	Broadcast	None	0	None	Pig	3.9	6	16.7	3.1	0.09	22
342-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Pig	3.9	6	16.7	3.1	0.09	12
343-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Pig	3.9	6	16.7	3.1	0.09	12
175-2000	2000	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Pig	3.9	6	16.7	3.1	0.09	9.7
176-2000	2000	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Pig	3.9	6	16.7	3.1	0.09	9.7
128-2000	2000	Autumn	Trailing hose	Grass	15	None	Cattle	6.4	6	14.6	3.33	0.09	19
136-2000	2000	Autumn	Trailing hose	None	0	None	Cattle	6.4	6	14.6	3.33	0.09	19
316-2000	2000	Autumn	Trailing hose	None	0	Shallow 24 hr	Cattle	6.4	6	14.6	3.33	0.09	12
317-2000	2000	Autumn	Trailing hose	None	0	Shallow 12 hr	Cattle	6.4	6	14.6	3.33	0.09	9.2
318-2000	2000	Autumn	Trailing hose	None	0	Shallow 6 hr	Cattle	6.4	6	14.6	3.33	0.09	7.4
319-2000	2000	Autumn	Trailing hose	None	0	Shallow 4 hr	Cattle	6.4	6	14.6	3.33	0.09	6.8
129-2000	2000	Autumn	Trailing hose	None	0	Deep 24 hr	Cattle	6.4	6	14.6	3.33	0.09	9.4
130-2000	2000	Autumn	Trailing hose	None	0	Deep 12 hr	Cattle	6.4	6	14.6	3.33	0.09	5.8
131-2000	2000	Autumn	Trailing hose	None	0	Deep 6 hr	Cattle	6.4	6	14.6	3.33	0.09	3.5
132-2000	2000	Autumn	Trailing hose	None	0	Deep 4 hr	Cattle	6.4	6	14.6	3.33	0.09	2.6
161-2000	2000	Autumn	Trailing hose	Grass	15	None	Pig	3.9	6	14.6	3.33	0.09	9.8

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
169-2000	2000	Autumn	Trailing hose	None	0	None	Pig	3.9	6	14.6	3.33	0.09	9.8
336-2000	2000	Autumn	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6	14.6	3.33	0.09	6.2
337-2000	2000	Autumn	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6	14.6	3.33	0.09	4.9
338-2000	2000	Autumn	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6	14.6	3.33	0.09	4
339-2000	2000	Autumn	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6	14.6	3.33	0.09	3.6
162-2000	2000	Autumn	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6	14.6	3.33	0.09	5.1
163-2000	2000	Autumn	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6	14.6	3.33	0.09	3.4
164-2000	2000	Autumn	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6	14.6	3.33	0.09	2.1
165-2000	2000	Autumn	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6	14.6	3.33	0.09	1.6
139-2000	2000	Winter-spring	Broadcast	None	0	None	Cattle	6.4	6	11.9	3.42	0.09	36
320-2000	2000	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Cattle	6.4	6	11.9	3.42	0.09	22
321-2000	2000	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Cattle	6.4	6	11.9	3.42	0.09	22
137-2000	2000	Winter-spring	Broadcast	None	0	Deep < 12 hr	Cattle	6.4	6	11.9	3.42	0.09	18
138-2000	2000	Winter-spring	Broadcast	None	0	Deep > 12 hr	Cattle	6.4	6	11.9	3.42	0.09	18
172-2000	2000	Winter-spring	Broadcast	None	0	None	Pig	3.9	6	11.9	3.42	0.09	21
340-2000	2000	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Pig	3.9	6	11.9	3.42	0.09	11
341-2000	2000	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Pig	3.9	6	11.9	3.42	0.09	11
170-2000	2000	Winter-spring	Broadcast	None	0	Deep < 12 hr	Pig	3.9	6	11.9	3.42	0.09	8.5

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
171-2000	2000	Winter-spring	Broadcast	None	0	Deep > 12 hr	Pig	3.9	6	11.9	3.42	0.09	8.5
120-1990	1990	March	Trailing hose	Winter cereal	15	None	Cattle	7	6	4.4	4.48	0.09	9.8
133-1990	1990	March	Trailing hose	None	0	None	Cattle	7	6	4.4	4.48	0.09	9.8
304-1990	1990	March	Trailing hose	None	0	Shallow 24 hr	Cattle	7	6	4.4	4.48	0.09	4.9
305-1990	1990	March	Trailing hose	None	0	Shallow 12 hr	Cattle	7	6	4.4	4.48	0.09	4
306-1990	1990	March	Trailing hose	None	0	Shallow 6 hr	Cattle	7	6	4.4	4.48	0.09	3.4
307-1990	1990	March	Trailing hose	None	0	Shallow 4 hr	Cattle	7	6	4.4	4.48	0.09	3.2
112-1990	1990	March	Trailing hose	None	0	Deep 24 hr	Cattle	7	6	4.4	4.48	0.09	3.2
113-1990	1990	March	Trailing hose	None	0	Deep 12 hr	Cattle	7	6	4.4	4.48	0.09	2
114-1990	1990	March	Trailing hose	None	0	Deep 6 hr	Cattle	7	6	4.4	4.48	0.09	1.2
115-1990	1990	March	Trailing hose	None	0	Deep 4 hr	Cattle	7	6	4.4	4.48	0.09	0.95
153-1990	1990	March	Trailing hose	Winter cereal	15	None	Pig	3.7	6	4.4	4.48	0.09	7.1
166-1990	1990	March	Trailing hose	None	0	None	Pig	3.7	6	4.4	4.48	0.09	7.1
324-1990	1990	March	Trailing hose	None	0	Shallow 24 hr	Pig	3.7	6	4.4	4.48	0.09	3.4
325-1990	1990	March	Trailing hose	None	0	Shallow 12 hr	Pig	3.7	6	4.4	4.48	0.09	2.8
326-1990	1990	March	Trailing hose	None	0	Shallow 6 hr	Pig	3.7	6	4.4	4.48	0.09	2.4
327-1990	1990	March	Trailing hose	None	0	Shallow 4 hr	Pig	3.7	6	4.4	4.48	0.09	2.2
145-1990	1990	March	Trailing hose	None	0	Deep 24 hr	Pig	3.7	6	4.4	4.48	0.09	2.3
146-1990	1990	March	Trailing hose	None	0	Deep 12 hr	Pig	3.7	6	4.4	4.48	0.09	1.4

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
147-1990	1990	March	Trailing hose	None	0	Deep 6 hr	Pig	3.7	6	4.4	4.48	0.09	0.89
148-1990	1990	March	Trailing hose	None	0	Deep 4 hr	Pig	3.7	6	4.4	4.48	0.09	0.71
121-1990	1990	April	Trailing hose	Winter cereal	25	None	Cattle	7	6	7.6	4.02	0.09	12
134-1990	1990	April	Trailing hose	None	0	None	Cattle	7	6	7.6	4.02	0.09	12
308-1990	1990	April	Trailing hose	None	0	Shallow 24 hr	Cattle	7	6	7.6	4.02	0.09	6.3
309-1990	1990	April	Trailing hose	None	0	Shallow 12 hr	Cattle	7	6	7.6	4.02	0.09	5
310-1990	1990	April	Trailing hose	None	0	Shallow 6 hr	Cattle	7	6	7.6	4.02	0.09	4.3
311-1990	1990	April	Trailing hose	None	0	Shallow 4 hr	Cattle	7	6	7.6	4.02	0.09	4
116-1990	1990	April	Trailing hose	None	0	Deep 24 hr	Cattle	7	6	7.6	4.02	0.09	4.4
117-1990	1990	April	Trailing hose	None	0	Deep 12 hr	Cattle	7	6	7.6	4.02	0.09	2.6
118-1990	1990	April	Trailing hose	None	0	Deep 6 hr	Cattle	7	6	7.6	4.02	0.09	1.6
119-1990	1990	April	Trailing hose	None	0	Deep 4 hr	Cattle	7	6	7.6	4.02	0.09	1.2
154-1990	1990	April	Trailing hose	Winter cereal	25	None	Pig	3.7	6	7.6	4.02	0.09	7.8
167-1990	1990	April	Trailing hose	None	0	None	Pig	3.7	6	7.6	4.02	0.09	7.8
328-1990	1990	April	Trailing hose	None	0	Shallow 24 hr	Pig	3.7	6	7.6	4.02	0.09	4
329-1990	1990	April	Trailing hose	None	0	Shallow 12 hr	Pig	3.7	6	7.6	4.02	0.09	3.2
330-1990	1990	April	Trailing hose	None	0	Shallow 6 hr	Pig	3.7	6	7.6	4.02	0.09	2.7
331-1990	1990	April	Trailing hose	None	0	Shallow 4 hr	Pig	3.7	6	7.6	4.02	0.09	2.5
149-1990	1990	April	Trailing hose	None	0	Deep 24 hr	Pig	3.7	6	7.6	4.02	0.09	2.8

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
150-1990	1990	April	Trailing hose	None	0	Deep 12 hr	Pig	3.7	6	7.6	4.02	0.09	1.8
151-1990	1990	April	Trailing hose	None	0	Deep 6 hr	Pig	3.7	6	7.6	4.02	0.09	1.1
152-1990	1990	April	Trailing hose	None	0	Deep 4 hr	Pig	3.7	6	7.6	4.02	0.09	0.86
122-1990	1990	May	Trailing hose	Spring cereal	15	None	Cattle	7	6	11.7	3.45	0.09	16
155-1990	1990	May	Trailing hose	Spring cereal	15	None	Pig	3.7	6	11.7	3.45	0.09	8.8
140-1990	1990	Spring-summer	Broadcast	Cereal and grass	15	None	Cattle	7	6	13.7	3.4	0.09	40
173-1990	1990	Spring-summer	Broadcast	Cereal and grass	15	None	Pig	3.7	6	13.7	3.4	0.09	21
123-1990	1990	Summer	Trailing hose	Grass	10	None	Cattle	7	6	16.4	3.18	0.09	22
135-1990	1990	Summer	Trailing hose	None	0	None	Cattle	7	6	16.4	3.18	0.09	22
312-1990	1990	Summer	Trailing hose	None	0	Shallow 24 hr	Cattle	7	6	16.4	3.18	0.09	14
313-1990	1990	Summer	Trailing hose	None	0	Shallow 12 hr	Cattle	7	6	16.4	3.18	0.09	11
314-1990	1990	Summer	Trailing hose	None	0	Shallow 6 hr	Cattle	7	6	16.4	3.18	0.09	8.8
315-1990	1990	Summer	Trailing hose	None	0	Shallow 4 hr	Cattle	7	6	16.4	3.18	0.09	8
124-1990	1990	Summer	Trailing hose	None	0	Deep 24 hr	Cattle	7	6	16.4	3.18	0.09	11
125-1990	1990	Summer	Trailing hose	None	0	Deep 12 hr	Cattle	7	6	16.4	3.18	0.09	7.1
126-1990	1990	Summer	Trailing hose	None	0	Deep 6 hr	Cattle	7	6	16.4	3.18	0.09	4.2
127-1990	1990	Summer	Trailing hose	None	0	Deep 4 hr	Cattle	7	6	16.4	3.18	0.09	3.1
156-1990	1990	Summer	Trailing hose	Grass	10	None	Pig	3.7	6	16.4	3.18	0.09	9.9
168-1990	1990	Summer	Trailing hose	None	0	None	Pig	3.7	6	16.4	3.18	0.09	9.9

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
332-1990	1990	Summer	Trailing hose	None	0	Shallow 24 hr	Pig	3.7	6	16.4	3.18	0.09	6.6
333-1990	1990	Summer	Trailing hose	None	0	Shallow 12 hr	Pig	3.7	6	16.4	3.18	0.09	5.3
334-1990	1990	Summer	Trailing hose	None	0	Shallow 6 hr	Pig	3.7	6	16.4	3.18	0.09	4.3
335-1990	1990	Summer	Trailing hose	None	0	Shallow 4 hr	Pig	3.7	6	16.4	3.18	0.09	3.8
157-1990	1990	Summer	Trailing hose	None	0	Deep 24 hr	Pig	3.7	6	16.4	3.18	0.09	5.6
158-1990	1990	Summer	Trailing hose	None	0	Deep 12 hr	Pig	3.7	6	16.4	3.18	0.09	3.9
159-1990	1990	Summer	Trailing hose	None	0	Deep 6 hr	Pig	3.7	6	16.4	3.18	0.09	2.5
160-1990	1990	Summer	Trailing hose	None	0	Deep 4 hr	Pig	3.7	6	16.4	3.18	0.09	1.9
141-1990	1990	Late summer-autumn	Broadcast	Grass	10	None	Cattle	7	6	16.1	3.18	0.09	42
144-1990	1990	Late summer-autumn	Broadcast	None	0	None	Cattle	7	6	16.1	3.18	0.09	42
322-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Cattle	7	6	16.1	3.18	0.09	30
323-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Cattle	7	6	16.1	3.18	0.09	30
142-1990	1990	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Cattle	7	6	16.1	3.18	0.09	26
143-1990	1990	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Cattle	7	6	16.1	3.18	0.09	26
174-1990	1990	Late summer-autumn	Broadcast	Grass	10	None	Pig	3.7	6	16.1	3.18	0.09	21

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
177-1990	1990	Late summer-autumn	Broadcast	None	0	None	Pig	3.7	6	16.1	3.18	0.09	21
342-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Pig	3.7	6	16.1	3.18	0.09	12
343-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Pig	3.7	6	16.1	3.18	0.09	12
175-1990	1990	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Pig	3.7	6	16.1	3.18	0.09	9.1
176-1990	1990	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Pig	3.7	6	16.1	3.18	0.09	9.1
128-1990	1990	Autumn	Trailing hose	Grass	15	None	Cattle	7	6	13.7	3.33	0.09	18
136-1990	1990	Autumn	Trailing hose	None	0	None	Cattle	7	6	13.7	3.33	0.09	18
316-1990	1990	Autumn	Trailing hose	None	0	Shallow 24 hr	Cattle	7	6	13.7	3.33	0.09	11
317-1990	1990	Autumn	Trailing hose	None	0	Shallow 12 hr	Cattle	7	6	13.7	3.33	0.09	8.4
318-1990	1990	Autumn	Trailing hose	None	0	Shallow 6 hr	Cattle	7	6	13.7	3.33	0.09	6.9
319-1990	1990	Autumn	Trailing hose	None	0	Shallow 4 hr	Cattle	7	6	13.7	3.33	0.09	6.4
129-1990	1990	Autumn	Trailing hose	None	0	Deep 24 hr	Cattle	7	6	13.7	3.33	0.09	8.3
130-1990	1990	Autumn	Trailing hose	None	0	Deep 12 hr	Cattle	7	6	13.7	3.33	0.09	5.1
131-1990	1990	Autumn	Trailing hose	None	0	Deep 6 hr	Cattle	7	6	13.7	3.33	0.09	3
132-1990	1990	Autumn	Trailing hose	None	0	Deep 4 hr	Cattle	7	6	13.7	3.33	0.09	2.2
161-1990	1990	Autumn	Trailing hose	Grass	15	None	Pig	3.7	6	13.7	3.33	0.09	9.3

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
169-1990	1990	Autumn	Trailing hose	None	0	None	Pig	3.7	6	13.7	3.33	0.09	9.3
336-1990	1990	Autumn	Trailing hose	None	0	Shallow 24 hr	Pig	3.7	6	13.7	3.33	0.09	5.7
337-1990	1990	Autumn	Trailing hose	None	0	Shallow 12 hr	Pig	3.7	6	13.7	3.33	0.09	4.5
338-1990	1990	Autumn	Trailing hose	None	0	Shallow 6 hr	Pig	3.7	6	13.7	3.33	0.09	3.7
339-1990	1990	Autumn	Trailing hose	None	0	Shallow 4 hr	Pig	3.7	6	13.7	3.33	0.09	3.3
162-1990	1990	Autumn	Trailing hose	None	0	Deep 24 hr	Pig	3.7	6	13.7	3.33	0.09	4.5
163-1990	1990	Autumn	Trailing hose	None	0	Deep 12 hr	Pig	3.7	6	13.7	3.33	0.09	3
164-1990	1990	Autumn	Trailing hose	None	0	Deep 6 hr	Pig	3.7	6	13.7	3.33	0.09	1.9
165-1990	1990	Autumn	Trailing hose	None	0	Deep 4 hr	Pig	3.7	6	13.7	3.33	0.09	1.4
139-1990	1990	Winter-spring	Broadcast	None	0	None	Cattle	7	6	11.3	3.59	0.09	38
320-1990	1990	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Cattle	7	6	11.3	3.59	0.09	23
321-1990	1990	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Cattle	7	6	11.3	3.59	0.09	23
137-1990	1990	Winter-spring	Broadcast	None	0	Deep < 12 hr	Cattle	7	6	11.3	3.59	0.09	17
138-1990	1990	Winter-spring	Broadcast	None	0	Deep > 12 hr	Cattle	7	6	11.3	3.59	0.09	17
172-1990	1990	Winter-spring	Broadcast	None	0	None	Pig	3.7	6	11.3	3.59	0.09	21
340-1990	1990	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Pig	3.7	6	11.3	3.59	0.09	11
341-1990	1990	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Pig	3.7	6	11.3	3.59	0.09	11
170-1990	1990	Winter-spring	Broadcast	None	0	Deep < 12 hr	Pig	3.7	6	11.3	3.59	0.09	8

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
171-1990	1990	Winter-spring	Broadcast	None	0	Deep > 12 hr	Pig	3.7	6	11.3	3.59	0.09	8
120-1980	1980	March	Trailing hose	Winter cereal	15	None	Cattle	7.3	6	3.3	4.37	0.09	8.7
133-1980	1980	March	Trailing hose	None	0	None	Cattle	7.3	6	3.3	4.37	0.09	8.7
304-1980	1980	March	Trailing hose	None	0	Shallow 24 hr	Cattle	7.3	6	3.3	4.37	0.09	4.2
305-1980	1980	March	Trailing hose	None	0	Shallow 12 hr	Cattle	7.3	6	3.3	4.37	0.09	3.4
306-1980	1980	March	Trailing hose	None	0	Shallow 6 hr	Cattle	7.3	6	3.3	4.37	0.09	3
307-1980	1980	March	Trailing hose	None	0	Shallow 4 hr	Cattle	7.3	6	3.3	4.37	0.09	2.8
112-1980	1980	March	Trailing hose	None	0	Deep 24 hr	Cattle	7.3	6	3.3	4.37	0.09	2.7
113-1980	1980	March	Trailing hose	None	0	Deep 12 hr	Cattle	7.3	6	3.3	4.37	0.09	1.6
114-1980	1980	March	Trailing hose	None	0	Deep 6 hr	Cattle	7.3	6	3.3	4.37	0.09	1
115-1980	1980	March	Trailing hose	None	0	Deep 4 hr	Cattle	7.3	6	3.3	4.37	0.09	0.81
153-1980	1980	March	Trailing hose	Winter cereal	15	None	Pig	3.2	6	3.3	4.37	0.09	6.5
166-1980	1980	March	Trailing hose	None	0	None	Pig	3.2	6	3.3	4.37	0.09	6.5
324-1980	1980	March	Trailing hose	None	0	Shallow 24 hr	Pig	3.2	6	3.3	4.37	0.09	3
325-1980	1980	March	Trailing hose	None	0	Shallow 12 hr	Pig	3.2	6	3.3	4.37	0.09	2.5
326-1980	1980	March	Trailing hose	None	0	Shallow 6 hr	Pig	3.2	6	3.3	4.37	0.09	2.1
327-1980	1980	March	Trailing hose	None	0	Shallow 4 hr	Pig	3.2	6	3.3	4.37	0.09	2
145-1980	1980	March	Trailing hose	None	0	Deep 24 hr	Pig	3.2	6	3.3	4.37	0.09	2
146-1980	1980	March	Trailing hose	None	0	Deep 12 hr	Pig	3.2	6	3.3	4.37	0.09	1.2

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
147-1980	1980	March	Trailing hose	None	0	Deep 6 hr	Pig	3.2	6	3.3	4.37	0.09	0.78
148-1980	1980	March	Trailing hose	None	0	Deep 4 hr	Pig	3.2	6	3.3	4.37	0.09	0.62
121-1980	1980	April	Trailing hose	Winter cereal	25	None	Cattle	7.3	6	6.8	3.79	0.09	11
134-1980	1980	April	Trailing hose	None	0	None	Cattle	7.3	6	6.8	3.79	0.09	11
308-1980	1980	April	Trailing hose	None	0	Shallow 24 hr	Cattle	7.3	6	6.8	3.79	0.09	5.4
309-1980	1980	April	Trailing hose	None	0	Shallow 12 hr	Cattle	7.3	6	6.8	3.79	0.09	4.3
310-1980	1980	April	Trailing hose	None	0	Shallow 6 hr	Cattle	7.3	6	6.8	3.79	0.09	3.7
311-1980	1980	April	Trailing hose	None	0	Shallow 4 hr	Cattle	7.3	6	6.8	3.79	0.09	3.5
116-1980	1980	April	Trailing hose	None	0	Deep 24 hr	Cattle	7.3	6	6.8	3.79	0.09	3.6
117-1980	1980	April	Trailing hose	None	0	Deep 12 hr	Cattle	7.3	6	6.8	3.79	0.09	2.2
118-1980	1980	April	Trailing hose	None	0	Deep 6 hr	Cattle	7.3	6	6.8	3.79	0.09	1.3
119-1980	1980	April	Trailing hose	None	0	Deep 4 hr	Cattle	7.3	6	6.8	3.79	0.09	1
154-1980	1980	April	Trailing hose	Winter cereal	25	None	Pig	3.2	6	6.8	3.79	0.09	7.1
167-1980	1980	April	Trailing hose	None	0	None	Pig	3.2	6	6.8	3.79	0.09	7.1
328-1980	1980	April	Trailing hose	None	0	Shallow 24 hr	Pig	3.2	6	6.8	3.79	0.09	3.5
329-1980	1980	April	Trailing hose	None	0	Shallow 12 hr	Pig	3.2	6	6.8	3.79	0.09	2.9
330-1980	1980	April	Trailing hose	None	0	Shallow 6 hr	Pig	3.2	6	6.8	3.79	0.09	2.4
331-1980	1980	April	Trailing hose	None	0	Shallow 4 hr	Pig	3.2	6	6.8	3.79	0.09	2.3
149-1980	1980	April	Trailing hose	None	0	Deep 24 hr	Pig	3.2	6	6.8	3.79	0.09	2.4

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
150-1980	1980	April	Trailing hose	None	0	Deep 12 hr	Pig	3.2	6	6.8	3.79	0.09	1.5
151-1980	1980	April	Trailing hose	None	0	Deep 6 hr	Pig	3.2	6	6.8	3.79	0.09	0.96
152-1980	1980	April	Trailing hose	None	0	Deep 4 hr	Pig	3.2	6	6.8	3.79	0.09	0.75
122-1980	1980	May	Trailing hose	Spring cereal	15	None	Cattle	7.3	6	12	3.68	0.09	17
155-1980	1980	May	Trailing hose	Spring cereal	15	None	Pig	3.2	6	12	3.68	0.09	8.4
140-1980	1980	Spring-summer	Broadcast	Cereal and grass	15	None	Cattle	7.3	6	13.1	3.4	0.09	41
173-1980	1980	Spring-summer	Broadcast	Cereal and grass	15	None	Pig	3.2	6	13.1	3.4	0.09	20
123-1980	1980	Summer	Trailing hose	Grass	10	None	Cattle	7.3	6	15.6	3.18	0.09	21
135-1980	1980	Summer	Trailing hose	None	0	None	Cattle	7.3	6	15.6	3.18	0.09	21
312-1980	1980	Summer	Trailing hose	None	0	Shallow 24 hr	Cattle	7.3	6	15.6	3.18	0.09	13
313-1980	1980	Summer	Trailing hose	None	0	Shallow 12 hr	Cattle	7.3	6	15.6	3.18	0.09	10
314-1980	1980	Summer	Trailing hose	None	0	Shallow 6 hr	Cattle	7.3	6	15.6	3.18	0.09	8.2
315-1980	1980	Summer	Trailing hose	None	0	Shallow 4 hr	Cattle	7.3	6	15.6	3.18	0.09	7.5
124-1980	1980	Summer	Trailing hose	None	0	Deep 24 hr	Cattle	7.3	6	15.6	3.18	0.09	10
125-1980	1980	Summer	Trailing hose	None	0	Deep 12 hr	Cattle	7.3	6	15.6	3.18	0.09	6.2
126-1980	1980	Summer	Trailing hose	None	0	Deep 6 hr	Cattle	7.3	6	15.6	3.18	0.09	3.7
127-1980	1980	Summer	Trailing hose	None	0	Deep 4 hr	Cattle	7.3	6	15.6	3.18	0.09	2.7
156-1980	1980	Summer	Trailing hose	Grass	10	None	Pig	3.2	6	15.6	3.18	0.09	9
168-1980	1980	Summer	Trailing hose	None	0	None	Pig	3.2	6	15.6	3.18	0.09	9

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
332-1980	1980	Summer	Trailing hose	None	0	Shallow 24 hr	Pig	3.2	6	15.6	3.18	0.09	5.8
333-1980	1980	Summer	Trailing hose	None	0	Shallow 12 hr	Pig	3.2	6	15.6	3.18	0.09	4.7
334-1980	1980	Summer	Trailing hose	None	0	Shallow 6 hr	Pig	3.2	6	15.6	3.18	0.09	3.8
335-1980	1980	Summer	Trailing hose	None	0	Shallow 4 hr	Pig	3.2	6	15.6	3.18	0.09	3.4
157-1980	1980	Summer	Trailing hose	None	0	Deep 24 hr	Pig	3.2	6	15.6	3.18	0.09	4.8
158-1980	1980	Summer	Trailing hose	None	0	Deep 12 hr	Pig	3.2	6	15.6	3.18	0.09	3.4
159-1980	1980	Summer	Trailing hose	None	0	Deep 6 hr	Pig	3.2	6	15.6	3.18	0.09	2.1
160-1980	1980	Summer	Trailing hose	None	0	Deep 4 hr	Pig	3.2	6	15.6	3.18	0.09	1.6
141-1980	1980	Late summer-autumn	Broadcast	Grass	10	None	Cattle	7.3	6	15.2	3.41	0.09	43
144-1980	1980	Late summer-autumn	Broadcast	None	0	None	Cattle	7.3	6	15.2	3.41	0.09	43
322-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Cattle	7.3	6	15.2	3.41	0.09	30
323-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Cattle	7.3	6	15.2	3.41	0.09	30
142-1980	1980	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Cattle	7.3	6	15.2	3.41	0.09	25
143-1980	1980	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Cattle	7.3	6	15.2	3.41	0.09	25
174-1980	1980	Late summer-autumn	Broadcast	Grass	10	None	Pig	3.2	6	15.2	3.41	0.09	20

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
177-1980	1980	Late summer-autumn	Broadcast	None	0	None	Pig	3.2	6	15.2	3.41	0.09	20
342-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Pig	3.2	6	15.2	3.41	0.09	11
343-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Pig	3.2	6	15.2	3.41	0.09	11
175-1980	1980	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Pig	3.2	6	15.2	3.41	0.09	8
176-1980	1980	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Pig	3.2	6	15.2	3.41	0.09	8
128-1980	1980	Autumn	Trailing hose	Grass	15	None	Cattle	7.3	6	13.6	3.45	0.09	19
136-1980	1980	Autumn	Trailing hose	None	0	None	Cattle	7.3	6	13.6	3.45	0.09	19
316-1980	1980	Autumn	Trailing hose	None	0	Shallow 24 hr	Cattle	7.3	6	13.6	3.45	0.09	11
317-1980	1980	Autumn	Trailing hose	None	0	Shallow 12 hr	Cattle	7.3	6	13.6	3.45	0.09	8.6
318-1980	1980	Autumn	Trailing hose	None	0	Shallow 6 hr	Cattle	7.3	6	13.6	3.45	0.09	7.1
319-1980	1980	Autumn	Trailing hose	None	0	Shallow 4 hr	Cattle	7.3	6	13.6	3.45	0.09	6.5
129-1980	1980	Autumn	Trailing hose	None	0	Deep 24 hr	Cattle	7.3	6	13.6	3.45	0.09	8.3
130-1980	1980	Autumn	Trailing hose	None	0	Deep 12 hr	Cattle	7.3	6	13.6	3.45	0.09	5.1
131-1980	1980	Autumn	Trailing hose	None	0	Deep 6 hr	Cattle	7.3	6	13.6	3.45	0.09	3
132-1980	1980	Autumn	Trailing hose	None	0	Deep 4 hr	Cattle	7.3	6	13.6	3.45	0.09	2.3
161-1980	1980	Autumn	Trailing hose	Grass	15	None	Pig	3.2	6	13.6	3.45	0.09	8.7

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
169-1980	1980	Autumn	Trailing hose	None	0	None	Pig	3.2	6	13.6	3.45	0.09	8.7
336-1980	1980	Autumn	Trailing hose	None	0	Shallow 24 hr	Pig	3.2	6	13.6	3.45	0.09	5.3
337-1980	1980	Autumn	Trailing hose	None	0	Shallow 12 hr	Pig	3.2	6	13.6	3.45	0.09	4.3
338-1980	1980	Autumn	Trailing hose	None	0	Shallow 6 hr	Pig	3.2	6	13.6	3.45	0.09	3.5
339-1980	1980	Autumn	Trailing hose	None	0	Shallow 4 hr	Pig	3.2	6	13.6	3.45	0.09	3.2
162-1980	1980	Autumn	Trailing hose	None	0	Deep 24 hr	Pig	3.2	6	13.6	3.45	0.09	4.3
163-1980	1980	Autumn	Trailing hose	None	0	Deep 12 hr	Pig	3.2	6	13.6	3.45	0.09	2.9
164-1980	1980	Autumn	Trailing hose	None	0	Deep 6 hr	Pig	3.2	6	13.6	3.45	0.09	1.8
165-1980	1980	Autumn	Trailing hose	None	0	Deep 4 hr	Pig	3.2	6	13.6	3.45	0.09	1.4
139-1980	1980	Winter-spring	Broadcast	None	0	None	Cattle	7.3	6	10.9	3.6	0.09	39
320-1980	1980	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Cattle	7.3	6	10.9	3.6	0.09	23
321-1980	1980	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Cattle	7.3	6	10.9	3.6	0.09	23
137-1980	1980	Winter-spring	Broadcast	None	0	Deep < 12 hr	Cattle	7.3	6	10.9	3.6	0.09	17
138-1980	1980	Winter-spring	Broadcast	None	0	Deep > 12 hr	Cattle	7.3	6	10.9	3.6	0.09	17
172-1980	1980	Winter-spring	Broadcast	None	0	None	Pig	3.2	6	10.9	3.6	0.09	20
340-1980	1980	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Pig	3.2	6	10.9	3.6	0.09	10
341-1980	1980	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Pig	3.2	6	10.9	3.6	0.09	10
170-1980	1980	Winter-spring	Broadcast	None	0	Deep < 12 hr	Pig	3.2	6	10.9	3.6	0.09	7.2

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed ($m\ s^{-1}$)	Rainfall rate ($mm\ h^{-1}$)	Emission factor (%)
171-1980	1980	Winter-spring	Broadcast	None	0	Deep > 12 hr	Pig	3.2	6	10.9	3.6	0.09	7.2

Table A1.3. New emission factors for field acidified manure as percentage of applied TAN. Decade column gives the start of each period (e.g., 1980 refers to 1980-1989). Air temperature and wind speed values presented here are adjusted (Section 3.3).

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
186-2010	2010	March	Trailing hose	Winter cereal	15	None	Cattle	6.5	6.4	4.9	4.02	0.09	14
199-2010	2010	March	Trailing hose	None	0	None	Cattle	6.5	6.4	4.9	4.02	0.09	14
344-2010	2010	March	Trailing hose	None	0	Shallow 24 hr	Cattle	6.5	6.4	4.9	4.02	0.09	7.4
345-2010	2010	March	Trailing hose	None	0	Shallow 12 hr	Cattle	6.5	6.4	4.9	4.02	0.09	5.9
346-2010	2010	March	Trailing hose	None	0	Shallow 6 hr	Cattle	6.5	6.4	4.9	4.02	0.09	5
347-2010	2010	March	Trailing hose	None	0	Shallow 4 hr	Cattle	6.5	6.4	4.9	4.02	0.09	4.7
178-2010	2010	March	Trailing hose	None	0	Deep 24 hr	Cattle	6.5	6.4	4.9	4.02	0.09	5.2
179-2010	2010	March	Trailing hose	None	0	Deep 12 hr	Cattle	6.5	6.4	4.9	4.02	0.09	3.2
180-2010	2010	March	Trailing hose	None	0	Deep 6 hr	Cattle	6.5	6.4	4.9	4.02	0.09	1.9
181-2010	2010	March	Trailing hose	None	0	Deep 4 hr	Cattle	6.5	6.4	4.9	4.02	0.09	1.5
219-2010	2010	March	Trailing hose	Winter cereal	15	None	Pig	3.9	6.4	4.9	4.02	0.09	9.2
232-2010	2010	March	Trailing hose	None	0	None	Pig	3.9	6.4	4.9	4.02	0.09	9.2
364-2010	2010	March	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6.4	4.9	4.02	0.09	4.8
365-2010	2010	March	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6.4	4.9	4.02	0.09	3.8
366-2010	2010	March	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6.4	4.9	4.02	0.09	3.2
367-2010	2010	March	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6.4	4.9	4.02	0.09	3
211-2010	2010	March	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6.4	4.9	4.02	0.09	3.4
212-2010	2010	March	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6.4	4.9	4.02	0.09	2.1
213-2010	2010	March	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6.4	4.9	4.02	0.09	1.3
214-2010	2010	March	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6.4	4.9	4.02	0.09	1
187-2010	2010	April	Trailing hose	Winter cereal	25	None	Cattle	6.5	6.4	8.5	3.91	0.09	18
200-2010	2010	April	Trailing hose	None	0	None	Cattle	6.5	6.4	8.5	3.91	0.09	18
348-2010	2010	April	Trailing hose	None	0	Shallow 24 hr	Cattle	6.5	6.4	8.5	3.91	0.09	11
349-2010	2010	April	Trailing hose	None	0	Shallow 12 hr	Cattle	6.5	6.4	8.5	3.91	0.09	8.3
350-2010	2010	April	Trailing hose	None	0	Shallow 6 hr	Cattle	6.5	6.4	8.5	3.91	0.09	6.9
351-2010	2010	April	Trailing hose	None	0	Shallow 4 hr	Cattle	6.5	6.4	8.5	3.91	0.09	6.3
182-2010	2010	April	Trailing hose	None	0	Deep 24 hr	Cattle	6.5	6.4	8.5	3.91	0.09	8.1
183-2010	2010	April	Trailing hose	None	0	Deep 12 hr	Cattle	6.5	6.4	8.5	3.91	0.09	5
184-2010	2010	April	Trailing hose	None	0	Deep 6 hr	Cattle	6.5	6.4	8.5	3.91	0.09	3
185-2010	2010	April	Trailing hose	None	0	Deep 4 hr	Cattle	6.5	6.4	8.5	3.91	0.09	2.2

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
220-2010	2010	April	Trailing hose	Winter cereal	25	None	Pig	3.9	6.4	8.5	3.91	0.09	10
233-2010	2010	April	Trailing hose	None	0	None	Pig	3.9	6.4	8.5	3.91	0.09	10
368-2010	2010	April	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6.4	8.5	3.91	0.09	6
369-2010	2010	April	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6.4	8.5	3.91	0.09	4.8
370-2010	2010	April	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6.4	8.5	3.91	0.09	4
371-2010	2010	April	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6.4	8.5	3.91	0.09	3.6
215-2010	2010	April	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6.4	8.5	3.91	0.09	4.7
216-2010	2010	April	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6.4	8.5	3.91	0.09	3
217-2010	2010	April	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6.4	8.5	3.91	0.09	1.9
218-2010	2010	April	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6.4	8.5	3.91	0.09	1.4
188-2010	2010	May	Trailing hose	Spring cereal	15	None	Cattle	6.5	6.4	12.4	3.56	0.09	22
221-2010	2010	May	Trailing hose	Spring cereal	15	None	Pig	3.9	6.4	12.4	3.56	0.09	11
206-2010	2010	Spring-summer	Broadcast	Cereal and grass	15	None	Cattle	6.5	6.4	14.3	3.4	0.09	42
239-2010	2010	Spring-summer	Broadcast	Cereal and grass	15	None	Pig	3.9	6.4	14.3	3.4	0.09	25
189-2010	2010	Summer	Trailing hose	Grass	10	None	Cattle	6.5	6.4	16.9	3.18	0.09	27
201-2010	2010	Summer	Trailing hose	None	0	None	Cattle	6.5	6.4	16.9	3.18	0.09	27
352-2010	2010	Summer	Trailing hose	None	0	Shallow 24 hr	Cattle	6.5	6.4	16.9	3.18	0.09	20
353-2010	2010	Summer	Trailing hose	None	0	Shallow 12 hr	Cattle	6.5	6.4	16.9	3.18	0.09	16
354-2010	2010	Summer	Trailing hose	None	0	Shallow 6 hr	Cattle	6.5	6.4	16.9	3.18	0.09	13
355-2010	2010	Summer	Trailing hose	None	0	Shallow 4 hr	Cattle	6.5	6.4	16.9	3.18	0.09	11
190-2010	2010	Summer	Trailing hose	None	0	Deep 24 hr	Cattle	6.5	6.4	16.9	3.18	0.09	18
191-2010	2010	Summer	Trailing hose	None	0	Deep 12 hr	Cattle	6.5	6.4	16.9	3.18	0.09	12
192-2010	2010	Summer	Trailing hose	None	0	Deep 6 hr	Cattle	6.5	6.4	16.9	3.18	0.09	7.5
193-2010	2010	Summer	Trailing hose	None	0	Deep 4 hr	Cattle	6.5	6.4	16.9	3.18	0.09	5.6
222-2010	2010	Summer	Trailing hose	Grass	10	None	Pig	3.9	6.4	16.9	3.18	0.09	12
234-2010	2010	Summer	Trailing hose	None	0	None	Pig	3.9	6.4	16.9	3.18	0.09	12
372-2010	2010	Summer	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6.4	16.9	3.18	0.09	8.7
373-2010	2010	Summer	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6.4	16.9	3.18	0.09	7.5
374-2010	2010	Summer	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6.4	16.9	3.18	0.09	6
375-2010	2010	Summer	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6.4	16.9	3.18	0.09	5.3

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
223-2010	2010	Summer	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6.4	16.9	3.18	0.09	7.7
224-2010	2010	Summer	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6.4	16.9	3.18	0.09	6
225-2010	2010	Summer	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6.4	16.9	3.18	0.09	4.1
226-2010	2010	Summer	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6.4	16.9	3.18	0.09	3.1
207-2010	2010	Late summer-autumn	Broadcast	Grass	10	None	Cattle	6.5	6.4	16.6	3.22	0.09	43
210-2010	2010	Late summer-autumn	Broadcast	None	0	None	Cattle	6.5	6.4	16.6	3.22	0.09	43
362-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Cattle	6.5	6.4	16.6	3.22	0.09	34
363-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Cattle	6.5	6.4	16.6	3.22	0.09	34
208-2010	2010	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Cattle	6.5	6.4	16.6	3.22	0.09	31
209-2010	2010	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Cattle	6.5	6.4	16.6	3.22	0.09	31
240-2010	2010	Late summer-autumn	Broadcast	Grass	10	None	Pig	3.9	6.4	16.6	3.22	0.09	25
243-2010	2010	Late summer-autumn	Broadcast	None	0	None	Pig	3.9	6.4	16.6	3.22	0.09	25
382-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Pig	3.9	6.4	16.6	3.22	0.09	14
383-2010	2010	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Pig	3.9	6.4	16.6	3.22	0.09	14

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
241-2010	2010	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Pig	3.9	6.4	16.6	3.22	0.09	10
242-2010	2010	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Pig	3.9	6.4	16.6	3.22	0.09	10
194-2010	2010	Autumn	Trailing hose	Grass	15	None	Cattle	6.5	6.4	14.6	3.45	0.09	25
202-2010	2010	Autumn	Trailing hose	None	0	None	Cattle	6.5	6.4	14.6	3.45	0.09	25
356-2010	2010	Autumn	Trailing hose	None	0	Shallow 24 hr	Cattle	6.5	6.4	14.6	3.45	0.09	18
357-2010	2010	Autumn	Trailing hose	None	0	Shallow 12 hr	Cattle	6.5	6.4	14.6	3.45	0.09	14
358-2010	2010	Autumn	Trailing hose	None	0	Shallow 6 hr	Cattle	6.5	6.4	14.6	3.45	0.09	11
359-2010	2010	Autumn	Trailing hose	None	0	Shallow 4 hr	Cattle	6.5	6.4	14.6	3.45	0.09	9.7
195-2010	2010	Autumn	Trailing hose	None	0	Deep 24 hr	Cattle	6.5	6.4	14.6	3.45	0.09	15
196-2010	2010	Autumn	Trailing hose	None	0	Deep 12 hr	Cattle	6.5	6.4	14.6	3.45	0.09	9.9
197-2010	2010	Autumn	Trailing hose	None	0	Deep 6 hr	Cattle	6.5	6.4	14.6	3.45	0.09	6
198-2010	2010	Autumn	Trailing hose	None	0	Deep 4 hr	Cattle	6.5	6.4	14.6	3.45	0.09	4.4
227-2010	2010	Autumn	Trailing hose	Grass	15	None	Pig	3.9	6.4	14.6	3.45	0.09	12
235-2010	2010	Autumn	Trailing hose	None	0	None	Pig	3.9	6.4	14.6	3.45	0.09	12
376-2010	2010	Autumn	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6.4	14.6	3.45	0.09	8.1
377-2010	2010	Autumn	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6.4	14.6	3.45	0.09	6.8
378-2010	2010	Autumn	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6.4	14.6	3.45	0.09	5.4
379-2010	2010	Autumn	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6.4	14.6	3.45	0.09	4.8
228-2010	2010	Autumn	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6.4	14.6	3.45	0.09	7
229-2010	2010	Autumn	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6.4	14.6	3.45	0.09	5.2
230-2010	2010	Autumn	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6.4	14.6	3.45	0.09	3.4
231-2010	2010	Autumn	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6.4	14.6	3.45	0.09	2.6
205-2010	2010	Winter-spring	Broadcast	None	0	None	Cattle	6.5	6.4	12	3.53	0.09	41
360-2010	2010	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Cattle	6.5	6.4	12	3.53	0.09	29
361-2010	2010	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Cattle	6.5	6.4	12	3.53	0.09	29
203-2010	2010	Winter-spring	Broadcast	None	0	Deep < 12 hr	Cattle	6.5	6.4	12	3.53	0.09	25

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
204-2010	2010	Winter-spring	Broadcast	None	0	Deep > 12 hr	Cattle	6.5	6.4	12	3.53	0.09	25
238-2010	2010	Winter-spring	Broadcast	None	0	None	Pig	3.9	6.4	12	3.53	0.09	25
380-2010	2010	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Pig	3.9	6.4	12	3.53	0.09	13
381-2010	2010	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Pig	3.9	6.4	12	3.53	0.09	13
236-2010	2010	Winter-spring	Broadcast	None	0	Deep < 12 hr	Pig	3.9	6.4	12	3.53	0.09	10
237-2010	2010	Winter-spring	Broadcast	None	0	Deep > 12 hr	Pig	3.9	6.4	12	3.53	0.09	10
186-2000	2000	March	Trailing hose	Winter cereal	15	None	Cattle	6.4	6.4	4	4.02	0.09	13
199-2000	2000	March	Trailing hose	None	0	None	Cattle	6.4	6.4	4	4.02	0.09	13
344-2000	2000	March	Trailing hose	None	0	Shallow 24 hr	Cattle	6.4	6.4	4	4.02	0.09	6.7
345-2000	2000	March	Trailing hose	None	0	Shallow 12 hr	Cattle	6.4	6.4	4	4.02	0.09	5.4
346-2000	2000	March	Trailing hose	None	0	Shallow 6 hr	Cattle	6.4	6.4	4	4.02	0.09	4.6
347-2000	2000	March	Trailing hose	None	0	Shallow 4 hr	Cattle	6.4	6.4	4	4.02	0.09	4.3
178-2000	2000	March	Trailing hose	None	0	Deep 24 hr	Cattle	6.4	6.4	4	4.02	0.09	4.6
179-2000	2000	March	Trailing hose	None	0	Deep 12 hr	Cattle	6.4	6.4	4	4.02	0.09	2.8
180-2000	2000	March	Trailing hose	None	0	Deep 6 hr	Cattle	6.4	6.4	4	4.02	0.09	1.7
181-2000	2000	March	Trailing hose	None	0	Deep 4 hr	Cattle	6.4	6.4	4	4.02	0.09	1.3
219-2000	2000	March	Trailing hose	Winter cereal	15	None	Pig	3.9	6.4	4	4.02	0.09	8.9
232-2000	2000	March	Trailing hose	None	0	None	Pig	3.9	6.4	4	4.02	0.09	8.9
364-2000	2000	March	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6.4	4	4.02	0.09	4.5
365-2000	2000	March	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6.4	4	4.02	0.09	3.6
366-2000	2000	March	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6.4	4	4.02	0.09	3.1
367-2000	2000	March	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6.4	4	4.02	0.09	2.9
211-2000	2000	March	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6.4	4	4.02	0.09	3.1
212-2000	2000	March	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6.4	4	4.02	0.09	1.9
213-2000	2000	March	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6.4	4	4.02	0.09	1.2
214-2000	2000	March	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6.4	4	4.02	0.09	0.95

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
187-2000	2000	April	Trailing hose	Winter cereal	25	None	Cattle	6.4	6.4	8.5	3.45	0.09	17
200-2000	2000	April	Trailing hose	None	0	None	Cattle	6.4	6.4	8.5	3.45	0.09	17
348-2000	2000	April	Trailing hose	None	0	Shallow 24 hr	Cattle	6.4	6.4	8.5	3.45	0.09	9.6
349-2000	2000	April	Trailing hose	None	0	Shallow 12 hr	Cattle	6.4	6.4	8.5	3.45	0.09	7.5
350-2000	2000	April	Trailing hose	None	0	Shallow 6 hr	Cattle	6.4	6.4	8.5	3.45	0.09	6.3
351-2000	2000	April	Trailing hose	None	0	Shallow 4 hr	Cattle	6.4	6.4	8.5	3.45	0.09	5.8
182-2000	2000	April	Trailing hose	None	0	Deep 24 hr	Cattle	6.4	6.4	8.5	3.45	0.09	7.2
183-2000	2000	April	Trailing hose	None	0	Deep 12 hr	Cattle	6.4	6.4	8.5	3.45	0.09	4.4
184-2000	2000	April	Trailing hose	None	0	Deep 6 hr	Cattle	6.4	6.4	8.5	3.45	0.09	2.6
185-2000	2000	April	Trailing hose	None	0	Deep 4 hr	Cattle	6.4	6.4	8.5	3.45	0.09	2
220-2000	2000	April	Trailing hose	Winter cereal	25	None	Pig	3.9	6.4	8.5	3.45	0.09	10
233-2000	2000	April	Trailing hose	None	0	None	Pig	3.9	6.4	8.5	3.45	0.09	10
368-2000	2000	April	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6.4	8.5	3.45	0.09	5.6
369-2000	2000	April	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6.4	8.5	3.45	0.09	4.5
370-2000	2000	April	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6.4	8.5	3.45	0.09	3.7
371-2000	2000	April	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6.4	8.5	3.45	0.09	3.5
215-2000	2000	April	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6.4	8.5	3.45	0.09	4.3
216-2000	2000	April	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6.4	8.5	3.45	0.09	2.7
217-2000	2000	April	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6.4	8.5	3.45	0.09	1.7
218-2000	2000	April	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6.4	8.5	3.45	0.09	1.3
188-2000	2000	May	Trailing hose	Spring cereal	15	None	Cattle	6.4	6.4	12.5	3.33	0.09	22
221-2000	2000	May	Trailing hose	Spring cereal	15	None	Pig	3.9	6.4	12.5	3.33	0.09	11
206-2000	2000	Spring-summer	Broadcast	Cereal and grass	15	None	Cattle	6.4	6.4	14.3	3.22	0.09	41
239-2000	2000	Spring-summer	Broadcast	Cereal and grass	15	None	Pig	3.9	6.4	14.3	3.22	0.09	25
189-2000	2000	Summer	Trailing hose	Grass	10	None	Cattle	6.4	6.4	16.9	3.1	0.09	26
201-2000	2000	Summer	Trailing hose	None	0	None	Cattle	6.4	6.4	16.9	3.1	0.09	26
352-2000	2000	Summer	Trailing hose	None	0	Shallow 24 hr	Cattle	6.4	6.4	16.9	3.1	0.09	20
353-2000	2000	Summer	Trailing hose	None	0	Shallow 12 hr	Cattle	6.4	6.4	16.9	3.1	0.09	16
354-2000	2000	Summer	Trailing hose	None	0	Shallow 6 hr	Cattle	6.4	6.4	16.9	3.1	0.09	12

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed ($m\ s^{-1}$)	Rainfall rate ($mm\ h^{-1}$)	Emission factor (%)
355-2000	2000	Summer	Trailing hose	None	0	Shallow 4 hr	Cattle	6.4	6.4	16.9	3.1	0.09	11
190-2000	2000	Summer	Trailing hose	None	0	Deep 24 hr	Cattle	6.4	6.4	16.9	3.1	0.09	18
191-2000	2000	Summer	Trailing hose	None	0	Deep 12 hr	Cattle	6.4	6.4	16.9	3.1	0.09	12
192-2000	2000	Summer	Trailing hose	None	0	Deep 6 hr	Cattle	6.4	6.4	16.9	3.1	0.09	7.4
193-2000	2000	Summer	Trailing hose	None	0	Deep 4 hr	Cattle	6.4	6.4	16.9	3.1	0.09	5.5
222-2000	2000	Summer	Trailing hose	Grass	10	None	Pig	3.9	6.4	16.9	3.1	0.09	12
234-2000	2000	Summer	Trailing hose	None	0	None	Pig	3.9	6.4	16.9	3.1	0.09	12
372-2000	2000	Summer	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6.4	16.9	3.1	0.09	8.7
373-2000	2000	Summer	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6.4	16.9	3.1	0.09	7.4
374-2000	2000	Summer	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6.4	16.9	3.1	0.09	6
375-2000	2000	Summer	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6.4	16.9	3.1	0.09	5.3
223-2000	2000	Summer	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6.4	16.9	3.1	0.09	7.7
224-2000	2000	Summer	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6.4	16.9	3.1	0.09	6
225-2000	2000	Summer	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6.4	16.9	3.1	0.09	4
226-2000	2000	Summer	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6.4	16.9	3.1	0.09	3.1
207-2000	2000	Late summer-autumn	Broadcast	Grass	10	None	Cattle	6.4	6.4	16.7	3.1	0.09	42
210-2000	2000	Late summer-autumn	Broadcast	None	0	None	Cattle	6.4	6.4	16.7	3.1	0.09	42
362-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Cattle	6.4	6.4	16.7	3.1	0.09	33
363-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Cattle	6.4	6.4	16.7	3.1	0.09	33
208-2000	2000	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Cattle	6.4	6.4	16.7	3.1	0.09	30
209-2000	2000	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Cattle	6.4	6.4	16.7	3.1	0.09	30

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
240-2000	2000	Late summer-autumn	Broadcast	Grass	10	None	Pig	3.9	6.4	16.7	3.1	0.09	25
243-2000	2000	Late summer-autumn	Broadcast	None	0	None	Pig	3.9	6.4	16.7	3.1	0.09	25
382-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Pig	3.9	6.4	16.7	3.1	0.09	14
383-2000	2000	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Pig	3.9	6.4	16.7	3.1	0.09	14
241-2000	2000	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Pig	3.9	6.4	16.7	3.1	0.09	10
242-2000	2000	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Pig	3.9	6.4	16.7	3.1	0.09	10
194-2000	2000	Autumn	Trailing hose	Grass	15	None	Cattle	6.4	6.4	14.6	3.33	0.09	24
202-2000	2000	Autumn	Trailing hose	None	0	None	Cattle	6.4	6.4	14.6	3.33	0.09	24
356-2000	2000	Autumn	Trailing hose	None	0	Shallow 24 hr	Cattle	6.4	6.4	14.6	3.33	0.09	17
357-2000	2000	Autumn	Trailing hose	None	0	Shallow 12 hr	Cattle	6.4	6.4	14.6	3.33	0.09	13
358-2000	2000	Autumn	Trailing hose	None	0	Shallow 6 hr	Cattle	6.4	6.4	14.6	3.33	0.09	11
359-2000	2000	Autumn	Trailing hose	None	0	Shallow 4 hr	Cattle	6.4	6.4	14.6	3.33	0.09	9.4
195-2000	2000	Autumn	Trailing hose	None	0	Deep 24 hr	Cattle	6.4	6.4	14.6	3.33	0.09	15
196-2000	2000	Autumn	Trailing hose	None	0	Deep 12 hr	Cattle	6.4	6.4	14.6	3.33	0.09	9.6
197-2000	2000	Autumn	Trailing hose	None	0	Deep 6 hr	Cattle	6.4	6.4	14.6	3.33	0.09	5.8
198-2000	2000	Autumn	Trailing hose	None	0	Deep 4 hr	Cattle	6.4	6.4	14.6	3.33	0.09	4.3
227-2000	2000	Autumn	Trailing hose	Grass	15	None	Pig	3.9	6.4	14.6	3.33	0.09	12
235-2000	2000	Autumn	Trailing hose	None	0	None	Pig	3.9	6.4	14.6	3.33	0.09	12
376-2000	2000	Autumn	Trailing hose	None	0	Shallow 24 hr	Pig	3.9	6.4	14.6	3.33	0.09	8
377-2000	2000	Autumn	Trailing hose	None	0	Shallow 12 hr	Pig	3.9	6.4	14.6	3.33	0.09	6.7
378-2000	2000	Autumn	Trailing hose	None	0	Shallow 6 hr	Pig	3.9	6.4	14.6	3.33	0.09	5.4
379-2000	2000	Autumn	Trailing hose	None	0	Shallow 4 hr	Pig	3.9	6.4	14.6	3.33	0.09	4.8
228-2000	2000	Autumn	Trailing hose	None	0	Deep 24 hr	Pig	3.9	6.4	14.6	3.33	0.09	6.9

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
229-2000	2000	Autumn	Trailing hose	None	0	Deep 12 hr	Pig	3.9	6.4	14.6	3.33	0.09	5.1
230-2000	2000	Autumn	Trailing hose	None	0	Deep 6 hr	Pig	3.9	6.4	14.6	3.33	0.09	3.3
231-2000	2000	Autumn	Trailing hose	None	0	Deep 4 hr	Pig	3.9	6.4	14.6	3.33	0.09	2.5
205-2000	2000	Winter-spring	Broadcast	None	0	None	Cattle	6.4	6.4	11.9	3.42	0.09	41
360-2000	2000	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Cattle	6.4	6.4	11.9	3.42	0.09	29
361-2000	2000	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Cattle	6.4	6.4	11.9	3.42	0.09	29
203-2000	2000	Winter-spring	Broadcast	None	0	Deep < 12 hr	Cattle	6.4	6.4	11.9	3.42	0.09	25
204-2000	2000	Winter-spring	Broadcast	None	0	Deep > 12 hr	Cattle	6.4	6.4	11.9	3.42	0.09	25
238-2000	2000	Winter-spring	Broadcast	None	0	None	Pig	3.9	6.4	11.9	3.42	0.09	25
380-2000	2000	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Pig	3.9	6.4	11.9	3.42	0.09	13
381-2000	2000	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Pig	3.9	6.4	11.9	3.42	0.09	13
236-2000	2000	Winter-spring	Broadcast	None	0	Deep < 12 hr	Pig	3.9	6.4	11.9	3.42	0.09	10
237-2000	2000	Winter-spring	Broadcast	None	0	Deep > 12 hr	Pig	3.9	6.4	11.9	3.42	0.09	10
186-1990	1990	March	Trailing hose	Winter cereal	15	None	Cattle	7	6.4	4.4	4.48	0.09	15
199-1990	1990	March	Trailing hose	None	0	None	Cattle	7	6.4	4.4	4.48	0.09	15
344-1990	1990	March	Trailing hose	None	0	Shallow 24 hr	Cattle	7	6.4	4.4	4.48	0.09	7.7
345-1990	1990	March	Trailing hose	None	0	Shallow 12 hr	Cattle	7	6.4	4.4	4.48	0.09	6.1
346-1990	1990	March	Trailing hose	None	0	Shallow 6 hr	Cattle	7	6.4	4.4	4.48	0.09	5.2
347-1990	1990	March	Trailing hose	None	0	Shallow 4 hr	Cattle	7	6.4	4.4	4.48	0.09	4.9
178-1990	1990	March	Trailing hose	None	0	Deep 24 hr	Cattle	7	6.4	4.4	4.48	0.09	5.4
179-1990	1990	March	Trailing hose	None	0	Deep 12 hr	Cattle	7	6.4	4.4	4.48	0.09	3.3
180-1990	1990	March	Trailing hose	None	0	Deep 6 hr	Cattle	7	6.4	4.4	4.48	0.09	2
181-1990	1990	March	Trailing hose	None	0	Deep 4 hr	Cattle	7	6.4	4.4	4.48	0.09	1.5

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
219-1990	1990	March	Trailing hose	Winter cereal	15	None	Pig	3.7	6.4	4.4	4.48	0.09	9.2
232-1990	1990	March	Trailing hose	None	0	None	Pig	3.7	6.4	4.4	4.48	0.09	9.2
364-1990	1990	March	Trailing hose	None	0	Shallow 24 hr	Pig	3.7	6.4	4.4	4.48	0.09	4.8
365-1990	1990	March	Trailing hose	None	0	Shallow 12 hr	Pig	3.7	6.4	4.4	4.48	0.09	3.9
366-1990	1990	March	Trailing hose	None	0	Shallow 6 hr	Pig	3.7	6.4	4.4	4.48	0.09	3.3
367-1990	1990	March	Trailing hose	None	0	Shallow 4 hr	Pig	3.7	6.4	4.4	4.48	0.09	3
211-1990	1990	March	Trailing hose	None	0	Deep 24 hr	Pig	3.7	6.4	4.4	4.48	0.09	3.5
212-1990	1990	March	Trailing hose	None	0	Deep 12 hr	Pig	3.7	6.4	4.4	4.48	0.09	2.2
213-1990	1990	March	Trailing hose	None	0	Deep 6 hr	Pig	3.7	6.4	4.4	4.48	0.09	1.4
214-1990	1990	March	Trailing hose	None	0	Deep 4 hr	Pig	3.7	6.4	4.4	4.48	0.09	1.1
187-1990	1990	April	Trailing hose	Winter cereal	25	None	Cattle	7	6.4	7.6	4.02	0.09	18
200-1990	1990	April	Trailing hose	None	0	None	Cattle	7	6.4	7.6	4.02	0.09	18
348-1990	1990	April	Trailing hose	None	0	Shallow 24 hr	Cattle	7	6.4	7.6	4.02	0.09	9.9
349-1990	1990	April	Trailing hose	None	0	Shallow 12 hr	Cattle	7	6.4	7.6	4.02	0.09	7.8
350-1990	1990	April	Trailing hose	None	0	Shallow 6 hr	Cattle	7	6.4	7.6	4.02	0.09	6.5
351-1990	1990	April	Trailing hose	None	0	Shallow 4 hr	Cattle	7	6.4	7.6	4.02	0.09	6
182-1990	1990	April	Trailing hose	None	0	Deep 24 hr	Cattle	7	6.4	7.6	4.02	0.09	7.3
183-1990	1990	April	Trailing hose	None	0	Deep 12 hr	Cattle	7	6.4	7.6	4.02	0.09	4.4
184-1990	1990	April	Trailing hose	None	0	Deep 6 hr	Cattle	7	6.4	7.6	4.02	0.09	2.7
185-1990	1990	April	Trailing hose	None	0	Deep 4 hr	Cattle	7	6.4	7.6	4.02	0.09	2
220-1990	1990	April	Trailing hose	Winter cereal	25	None	Pig	3.7	6.4	7.6	4.02	0.09	9.9
233-1990	1990	April	Trailing hose	None	0	None	Pig	3.7	6.4	7.6	4.02	0.09	9.9
368-1990	1990	April	Trailing hose	None	0	Shallow 24 hr	Pig	3.7	6.4	7.6	4.02	0.09	5.6
369-1990	1990	April	Trailing hose	None	0	Shallow 12 hr	Pig	3.7	6.4	7.6	4.02	0.09	4.5
370-1990	1990	April	Trailing hose	None	0	Shallow 6 hr	Pig	3.7	6.4	7.6	4.02	0.09	3.7
371-1990	1990	April	Trailing hose	None	0	Shallow 4 hr	Pig	3.7	6.4	7.6	4.02	0.09	3.4
215-1990	1990	April	Trailing hose	None	0	Deep 24 hr	Pig	3.7	6.4	7.6	4.02	0.09	4.3
216-1990	1990	April	Trailing hose	None	0	Deep 12 hr	Pig	3.7	6.4	7.6	4.02	0.09	2.8
217-1990	1990	April	Trailing hose	None	0	Deep 6 hr	Pig	3.7	6.4	7.6	4.02	0.09	1.7
218-1990	1990	April	Trailing hose	None	0	Deep 4 hr	Pig	3.7	6.4	7.6	4.02	0.09	1.3
188-1990	1990	May	Trailing hose	Spring ce-real	15	None	Cattle	7	6.4	11.7	3.45	0.09	22

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
221-1990	1990	May	Trailing hose	Spring cereal	15	None	Pig	3.7	6.4	11.7	3.45	0.09	11
206-1990	1990	Spring-summer	Broadcast	Cereal and grass	15	None	Cattle	7	6.4	13.7	3.4	0.09	45
239-1990	1990	Spring-summer	Broadcast	Cereal and grass	15	None	Pig	3.7	6.4	13.7	3.4	0.09	24
189-1990	1990	Summer	Trailing hose	Grass	10	None	Cattle	7	6.4	16.4	3.18	0.09	28
201-1990	1990	Summer	Trailing hose	None	0	None	Cattle	7	6.4	16.4	3.18	0.09	28
352-1990	1990	Summer	Trailing hose	None	0	Shallow 24 hr	Cattle	7	6.4	16.4	3.18	0.09	20
353-1990	1990	Summer	Trailing hose	None	0	Shallow 12 hr	Cattle	7	6.4	16.4	3.18	0.09	16
354-1990	1990	Summer	Trailing hose	None	0	Shallow 6 hr	Cattle	7	6.4	16.4	3.18	0.09	12
355-1990	1990	Summer	Trailing hose	None	0	Shallow 4 hr	Cattle	7	6.4	16.4	3.18	0.09	11
190-1990	1990	Summer	Trailing hose	None	0	Deep 24 hr	Cattle	7	6.4	16.4	3.18	0.09	18
191-1990	1990	Summer	Trailing hose	None	0	Deep 12 hr	Cattle	7	6.4	16.4	3.18	0.09	12
192-1990	1990	Summer	Trailing hose	None	0	Deep 6 hr	Cattle	7	6.4	16.4	3.18	0.09	7.1
193-1990	1990	Summer	Trailing hose	None	0	Deep 4 hr	Cattle	7	6.4	16.4	3.18	0.09	5.2
222-1990	1990	Summer	Trailing hose	Grass	10	None	Pig	3.7	6.4	16.4	3.18	0.09	12
234-1990	1990	Summer	Trailing hose	None	0	None	Pig	3.7	6.4	16.4	3.18	0.09	12
372-1990	1990	Summer	Trailing hose	None	0	Shallow 24 hr	Pig	3.7	6.4	16.4	3.18	0.09	8.2
373-1990	1990	Summer	Trailing hose	None	0	Shallow 12 hr	Pig	3.7	6.4	16.4	3.18	0.09	7
374-1990	1990	Summer	Trailing hose	None	0	Shallow 6 hr	Pig	3.7	6.4	16.4	3.18	0.09	5.7
375-1990	1990	Summer	Trailing hose	None	0	Shallow 4 hr	Pig	3.7	6.4	16.4	3.18	0.09	5.1
223-1990	1990	Summer	Trailing hose	None	0	Deep 24 hr	Pig	3.7	6.4	16.4	3.18	0.09	7.2
224-1990	1990	Summer	Trailing hose	None	0	Deep 12 hr	Pig	3.7	6.4	16.4	3.18	0.09	5.6
225-1990	1990	Summer	Trailing hose	None	0	Deep 6 hr	Pig	3.7	6.4	16.4	3.18	0.09	3.8
226-1990	1990	Summer	Trailing hose	None	0	Deep 4 hr	Pig	3.7	6.4	16.4	3.18	0.09	2.9
207-1990	1990	Late summer-autumn	Broadcast	Grass	10	None	Cattle	7	6.4	16.1	3.18	0.09	46
210-1990	1990	Late summer-autumn	Broadcast	None	0	None	Cattle	7	6.4	16.1	3.18	0.09	46
362-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Cattle	7	6.4	16.1	3.18	0.09	36

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
363-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Cattle	7	6.4	16.1	3.18	0.09	36
208-1990	1990	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Cattle	7	6.4	16.1	3.18	0.09	33
209-1990	1990	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Cattle	7	6.4	16.1	3.18	0.09	33
240-1990	1990	Late summer-autumn	Broadcast	Grass	10	None	Pig	3.7	6.4	16.1	3.18	0.09	24
243-1990	1990	Late summer-autumn	Broadcast	None	0	None	Pig	3.7	6.4	16.1	3.18	0.09	24
382-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Pig	3.7	6.4	16.1	3.18	0.09	13
383-1990	1990	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Pig	3.7	6.4	16.1	3.18	0.09	13
241-1990	1990	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Pig	3.7	6.4	16.1	3.18	0.09	9.9
242-1990	1990	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Pig	3.7	6.4	16.1	3.18	0.09	9.9
194-1990	1990	Autumn	Trailing hose	Grass	15	None	Cattle	7	6.4	13.7	3.33	0.09	25
202-1990	1990	Autumn	Trailing hose	None	0	None	Cattle	7	6.4	13.7	3.33	0.09	25
356-1990	1990	Autumn	Trailing hose	None	0	Shallow 24 hr	Cattle	7	6.4	13.7	3.33	0.09	16
357-1990	1990	Autumn	Trailing hose	None	0	Shallow 12 hr	Cattle	7	6.4	13.7	3.33	0.09	13
358-1990	1990	Autumn	Trailing hose	None	0	Shallow 6 hr	Cattle	7	6.4	13.7	3.33	0.09	10
359-1990	1990	Autumn	Trailing hose	None	0	Shallow 4 hr	Cattle	7	6.4	13.7	3.33	0.09	9.1
195-1990	1990	Autumn	Trailing hose	None	0	Deep 24 hr	Cattle	7	6.4	13.7	3.33	0.09	13
196-1990	1990	Autumn	Trailing hose	None	0	Deep 12 hr	Cattle	7	6.4	13.7	3.33	0.09	8.5

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
197-1990	1990	Autumn	Trailing hose	None	0	Deep 6 hr	Cattle	7	6.4	13.7	3.33	0.09	5.1
198-1990	1990	Autumn	Trailing hose	None	0	Deep 4 hr	Cattle	7	6.4	13.7	3.33	0.09	3.7
227-1990	1990	Autumn	Trailing hose	Grass	15	None	Pig	3.7	6.4	13.7	3.33	0.09	11
235-1990	1990	Autumn	Trailing hose	None	0	None	Pig	3.7	6.4	13.7	3.33	0.09	11
376-1990	1990	Autumn	Trailing hose	None	0	Shallow 24 hr	Pig	3.7	6.4	13.7	3.33	0.09	7.4
377-1990	1990	Autumn	Trailing hose	None	0	Shallow 12 hr	Pig	3.7	6.4	13.7	3.33	0.09	6.1
378-1990	1990	Autumn	Trailing hose	None	0	Shallow 6 hr	Pig	3.7	6.4	13.7	3.33	0.09	4.9
379-1990	1990	Autumn	Trailing hose	None	0	Shallow 4 hr	Pig	3.7	6.4	13.7	3.33	0.09	4.4
228-1990	1990	Autumn	Trailing hose	None	0	Deep 24 hr	Pig	3.7	6.4	13.7	3.33	0.09	6.3
229-1990	1990	Autumn	Trailing hose	None	0	Deep 12 hr	Pig	3.7	6.4	13.7	3.33	0.09	4.5
230-1990	1990	Autumn	Trailing hose	None	0	Deep 6 hr	Pig	3.7	6.4	13.7	3.33	0.09	2.9
231-1990	1990	Autumn	Trailing hose	None	0	Deep 4 hr	Pig	3.7	6.4	13.7	3.33	0.09	2.2
205-1990	1990	Winter-spring	Broadcast	None	0	None	Cattle	7	6.4	11.3	3.59	0.09	44
360-1990	1990	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Cattle	7	6.4	11.3	3.59	0.09	30
361-1990	1990	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Cattle	7	6.4	11.3	3.59	0.09	30
203-1990	1990	Winter-spring	Broadcast	None	0	Deep < 12 hr	Cattle	7	6.4	11.3	3.59	0.09	25
204-1990	1990	Winter-spring	Broadcast	None	0	Deep > 12 hr	Cattle	7	6.4	11.3	3.59	0.09	25
238-1990	1990	Winter-spring	Broadcast	None	0	None	Pig	3.7	6.4	11.3	3.59	0.09	24
380-1990	1990	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Pig	3.7	6.4	11.3	3.59	0.09	13
381-1990	1990	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Pig	3.7	6.4	11.3	3.59	0.09	13
236-1990	1990	Winter-spring	Broadcast	None	0	Deep < 12 hr	Pig	3.7	6.4	11.3	3.59	0.09	9.5
237-1990	1990	Winter-spring	Broadcast	None	0	Deep > 12 hr	Pig	3.7	6.4	11.3	3.59	0.09	9.5
186-1980	1980	March	Trailing hose	Winter cereal	15	None	Cattle	7.3	6.4	3.3	4.37	0.09	13
199-1980	1980	March	Trailing hose	None	0	None	Cattle	7.3	6.4	3.3	4.37	0.09	13

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
344-1980	1980	March	Trailing hose	None	0	Shallow 24 hr	Cattle	7.3	6.4	3.3	4.37	0.09	6.6
345-1980	1980	March	Trailing hose	None	0	Shallow 12 hr	Cattle	7.3	6.4	3.3	4.37	0.09	5.3
346-1980	1980	March	Trailing hose	None	0	Shallow 6 hr	Cattle	7.3	6.4	3.3	4.37	0.09	4.5
347-1980	1980	March	Trailing hose	None	0	Shallow 4 hr	Cattle	7.3	6.4	3.3	4.37	0.09	4.3
178-1980	1980	March	Trailing hose	None	0	Deep 24 hr	Cattle	7.3	6.4	3.3	4.37	0.09	4.5
179-1980	1980	March	Trailing hose	None	0	Deep 12 hr	Cattle	7.3	6.4	3.3	4.37	0.09	2.7
180-1980	1980	March	Trailing hose	None	0	Deep 6 hr	Cattle	7.3	6.4	3.3	4.37	0.09	1.7
181-1980	1980	March	Trailing hose	None	0	Deep 4 hr	Cattle	7.3	6.4	3.3	4.37	0.09	1.3
219-1980	1980	March	Trailing hose	Winter cereal	15	None	Pig	3.2	6.4	3.3	4.37	0.09	8.5
232-1980	1980	March	Trailing hose	None	0	None	Pig	3.2	6.4	3.3	4.37	0.09	8.5
364-1980	1980	March	Trailing hose	None	0	Shallow 24 hr	Pig	3.2	6.4	3.3	4.37	0.09	4.2
365-1980	1980	March	Trailing hose	None	0	Shallow 12 hr	Pig	3.2	6.4	3.3	4.37	0.09	3.4
366-1980	1980	March	Trailing hose	None	0	Shallow 6 hr	Pig	3.2	6.4	3.3	4.37	0.09	2.9
367-1980	1980	March	Trailing hose	None	0	Shallow 4 hr	Pig	3.2	6.4	3.3	4.37	0.09	2.7
211-1980	1980	March	Trailing hose	None	0	Deep 24 hr	Pig	3.2	6.4	3.3	4.37	0.09	2.9
212-1980	1980	March	Trailing hose	None	0	Deep 12 hr	Pig	3.2	6.4	3.3	4.37	0.09	1.9
213-1980	1980	March	Trailing hose	None	0	Deep 6 hr	Pig	3.2	6.4	3.3	4.37	0.09	1.2
214-1980	1980	March	Trailing hose	None	0	Deep 4 hr	Pig	3.2	6.4	3.3	4.37	0.09	0.92
187-1980	1980	April	Trailing hose	Winter cereal	25	None	Cattle	7.3	6.4	6.8	3.79	0.09	16
200-1980	1980	April	Trailing hose	None	0	None	Cattle	7.3	6.4	6.8	3.79	0.09	16
348-1980	1980	April	Trailing hose	None	0	Shallow 24 hr	Cattle	7.3	6.4	6.8	3.79	0.09	8.5
349-1980	1980	April	Trailing hose	None	0	Shallow 12 hr	Cattle	7.3	6.4	6.8	3.79	0.09	6.8
350-1980	1980	April	Trailing hose	None	0	Shallow 6 hr	Cattle	7.3	6.4	6.8	3.79	0.09	5.7
351-1980	1980	April	Trailing hose	None	0	Shallow 4 hr	Cattle	7.3	6.4	6.8	3.79	0.09	5.3
182-1980	1980	April	Trailing hose	None	0	Deep 24 hr	Cattle	7.3	6.4	6.8	3.79	0.09	6.1
183-1980	1980	April	Trailing hose	None	0	Deep 12 hr	Cattle	7.3	6.4	6.8	3.79	0.09	3.7
184-1980	1980	April	Trailing hose	None	0	Deep 6 hr	Cattle	7.3	6.4	6.8	3.79	0.09	2.2
185-1980	1980	April	Trailing hose	None	0	Deep 4 hr	Cattle	7.3	6.4	6.8	3.79	0.09	1.7
220-1980	1980	April	Trailing hose	Winter cereal	25	None	Pig	3.2	6.4	6.8	3.79	0.09	9.1
233-1980	1980	April	Trailing hose	None	0	None	Pig	3.2	6.4	6.8	3.79	0.09	9.1
368-1980	1980	April	Trailing hose	None	0	Shallow 24 hr	Pig	3.2	6.4	6.8	3.79	0.09	4.9
369-1980	1980	April	Trailing hose	None	0	Shallow 12 hr	Pig	3.2	6.4	6.8	3.79	0.09	3.9

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
370-1980	1980	April	Trailing hose	None	0	Shallow 6 hr	Pig	3.2	6.4	6.8	3.79	0.09	3.3
371-1980	1980	April	Trailing hose	None	0	Shallow 4 hr	Pig	3.2	6.4	6.8	3.79	0.09	3.1
215-1980	1980	April	Trailing hose	None	0	Deep 24 hr	Pig	3.2	6.4	6.8	3.79	0.09	3.6
216-1980	1980	April	Trailing hose	None	0	Deep 12 hr	Pig	3.2	6.4	6.8	3.79	0.09	2.3
217-1980	1980	April	Trailing hose	None	0	Deep 6 hr	Pig	3.2	6.4	6.8	3.79	0.09	1.5
218-1980	1980	April	Trailing hose	None	0	Deep 4 hr	Pig	3.2	6.4	6.8	3.79	0.09	1.1
188-1980	1980	May	Trailing hose	Spring ce-real	15	None	Cattle	7.3	6.4	12	3.68	0.09	23
221-1980	1980	May	Trailing hose	Spring ce-real	15	None	Pig	3.2	6.4	12	3.68	0.09	10
206-1980	1980	Spring-summer	Broadcast	Cereal and grass	15	None	Cattle	7.3	6.4	13.1	3.4	0.09	46
239-1980	1980	Spring-summer	Broadcast	Cereal and grass	15	None	Pig	3.2	6.4	13.1	3.4	0.09	23
189-1980	1980	Summer	Trailing hose	Grass	10	None	Cattle	7.3	6.4	15.6	3.18	0.09	28
201-1980	1980	Summer	Trailing hose	None	0	None	Cattle	7.3	6.4	15.6	3.18	0.09	28
352-1980	1980	Summer	Trailing hose	None	0	Shallow 24 hr	Cattle	7.3	6.4	15.6	3.18	0.09	19
353-1980	1980	Summer	Trailing hose	None	0	Shallow 12 hr	Cattle	7.3	6.4	15.6	3.18	0.09	15
354-1980	1980	Summer	Trailing hose	None	0	Shallow 6 hr	Cattle	7.3	6.4	15.6	3.18	0.09	12
355-1980	1980	Summer	Trailing hose	None	0	Shallow 4 hr	Cattle	7.3	6.4	15.6	3.18	0.09	11
190-1980	1980	Summer	Trailing hose	None	0	Deep 24 hr	Cattle	7.3	6.4	15.6	3.18	0.09	16
191-1980	1980	Summer	Trailing hose	None	0	Deep 12 hr	Cattle	7.3	6.4	15.6	3.18	0.09	10
192-1980	1980	Summer	Trailing hose	None	0	Deep 6 hr	Cattle	7.3	6.4	15.6	3.18	0.09	6.2
193-1980	1980	Summer	Trailing hose	None	0	Deep 4 hr	Cattle	7.3	6.4	15.6	3.18	0.09	4.6
222-1980	1980	Summer	Trailing hose	Grass	10	None	Pig	3.2	6.4	15.6	3.18	0.09	11
234-1980	1980	Summer	Trailing hose	None	0	None	Pig	3.2	6.4	15.6	3.18	0.09	11
372-1980	1980	Summer	Trailing hose	None	0	Shallow 24 hr	Pig	3.2	6.4	15.6	3.18	0.09	7.2
373-1980	1980	Summer	Trailing hose	None	0	Shallow 12 hr	Pig	3.2	6.4	15.6	3.18	0.09	6.2
374-1980	1980	Summer	Trailing hose	None	0	Shallow 6 hr	Pig	3.2	6.4	15.6	3.18	0.09	5
375-1980	1980	Summer	Trailing hose	None	0	Shallow 4 hr	Pig	3.2	6.4	15.6	3.18	0.09	4.5
223-1980	1980	Summer	Trailing hose	None	0	Deep 24 hr	Pig	3.2	6.4	15.6	3.18	0.09	6.2
224-1980	1980	Summer	Trailing hose	None	0	Deep 12 hr	Pig	3.2	6.4	15.6	3.18	0.09	4.8
225-1980	1980	Summer	Trailing hose	None	0	Deep 6 hr	Pig	3.2	6.4	15.6	3.18	0.09	3.3
226-1980	1980	Summer	Trailing hose	None	0	Deep 4 hr	Pig	3.2	6.4	15.6	3.18	0.09	2.5

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
207-1980	1980	Late summer-autumn	Broadcast	Grass	10	None	Cattle	7.3	6.4	15.2	3.41	0.09	47
210-1980	1980	Late summer-autumn	Broadcast	None	0	None	Cattle	7.3	6.4	15.2	3.41	0.09	47
362-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Cattle	7.3	6.4	15.2	3.41	0.09	37
363-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Cattle	7.3	6.4	15.2	3.41	0.09	37
208-1980	1980	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Cattle	7.3	6.4	15.2	3.41	0.09	33
209-1980	1980	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Cattle	7.3	6.4	15.2	3.41	0.09	33
240-1980	1980	Late summer-autumn	Broadcast	Grass	10	None	Pig	3.2	6.4	15.2	3.41	0.09	23
243-1980	1980	Late summer-autumn	Broadcast	None	0	None	Pig	3.2	6.4	15.2	3.41	0.09	23
382-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow < 12 hr	Pig	3.2	6.4	15.2	3.41	0.09	12
383-1980	1980	Late summer-autumn	Broadcast	None	0	Shallow > 12 hr	Pig	3.2	6.4	15.2	3.41	0.09	12
241-1980	1980	Late summer-autumn	Broadcast	None	0	Deep < 12 hr	Pig	3.2	6.4	15.2	3.41	0.09	8.6

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed (m s^{-1})	Rainfall rate (mm h^{-1})	Emission factor (%)
242-1980	1980	Late summer-autumn	Broadcast	None	0	Deep > 12 hr	Pig	3.2	6.4	15.2	3.41	0.09	8.6
194-1980	1980	Autumn	Trailing hose	Grass	15	None	Cattle	7.3	6.4	13.6	3.45	0.09	25
202-1980	1980	Autumn	Trailing hose	None	0	None	Cattle	7.3	6.4	13.6	3.45	0.09	25
356-1980	1980	Autumn	Trailing hose	None	0	Shallow 24 hr	Cattle	7.3	6.4	13.6	3.45	0.09	17
357-1980	1980	Autumn	Trailing hose	None	0	Shallow 12 hr	Cattle	7.3	6.4	13.6	3.45	0.09	13
358-1980	1980	Autumn	Trailing hose	None	0	Shallow 6 hr	Cattle	7.3	6.4	13.6	3.45	0.09	10
359-1980	1980	Autumn	Trailing hose	None	0	Shallow 4 hr	Cattle	7.3	6.4	13.6	3.45	0.09	9.4
195-1980	1980	Autumn	Trailing hose	None	0	Deep 24 hr	Cattle	7.3	6.4	13.6	3.45	0.09	14
196-1980	1980	Autumn	Trailing hose	None	0	Deep 12 hr	Cattle	7.3	6.4	13.6	3.45	0.09	8.6
197-1980	1980	Autumn	Trailing hose	None	0	Deep 6 hr	Cattle	7.3	6.4	13.6	3.45	0.09	5.1
198-1980	1980	Autumn	Trailing hose	None	0	Deep 4 hr	Cattle	7.3	6.4	13.6	3.45	0.09	3.8
227-1980	1980	Autumn	Trailing hose	Grass	15	None	Pig	3.2	6.4	13.6	3.45	0.09	10
235-1980	1980	Autumn	Trailing hose	None	0	None	Pig	3.2	6.4	13.6	3.45	0.09	10
376-1980	1980	Autumn	Trailing hose	None	0	Shallow 24 hr	Pig	3.2	6.4	13.6	3.45	0.09	6.8
377-1980	1980	Autumn	Trailing hose	None	0	Shallow 12 hr	Pig	3.2	6.4	13.6	3.45	0.09	5.7
378-1980	1980	Autumn	Trailing hose	None	0	Shallow 6 hr	Pig	3.2	6.4	13.6	3.45	0.09	4.6
379-1980	1980	Autumn	Trailing hose	None	0	Shallow 4 hr	Pig	3.2	6.4	13.6	3.45	0.09	4.2
228-1980	1980	Autumn	Trailing hose	None	0	Deep 24 hr	Pig	3.2	6.4	13.6	3.45	0.09	5.8
229-1980	1980	Autumn	Trailing hose	None	0	Deep 12 hr	Pig	3.2	6.4	13.6	3.45	0.09	4.3
230-1980	1980	Autumn	Trailing hose	None	0	Deep 6 hr	Pig	3.2	6.4	13.6	3.45	0.09	2.8
231-1980	1980	Autumn	Trailing hose	None	0	Deep 4 hr	Pig	3.2	6.4	13.6	3.45	0.09	2.2
205-1980	1980	Winter-spring	Broadcast	None	0	None	Cattle	7.3	6.4	10.9	3.6	0.09	45
360-1980	1980	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Cattle	7.3	6.4	10.9	3.6	0.09	30
361-1980	1980	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Cattle	7.3	6.4	10.9	3.6	0.09	30
203-1980	1980	Winter-spring	Broadcast	None	0	Deep < 12 hr	Cattle	7.3	6.4	10.9	3.6	0.09	25
204-1980	1980	Winter-spring	Broadcast	None	0	Deep > 12 hr	Cattle	7.3	6.4	10.9	3.6	0.09	25
238-1980	1980	Winter-spring	Broadcast	None	0	None	Pig	3.2	6.4	10.9	3.6	0.09	23

Application condition ID	Decade	Application period	Application method	Crop	Crop height (cm)	Deep incorporation time (h)	Manure type	Manure dry matter (%)	Manure pH	Adjusted air temp. (°C)	Adjusted wind speed ($m\ s^{-1}$)	Rainfall rate ($mm\ h^{-1}$)	Emission factor (%)
380-1980	1980	Winter-spring	Broadcast	None	0	Shallow < 12 hr	Pig	3.2	6.4	10.9	3.6	0.09	12
381-1980	1980	Winter-spring	Broadcast	None	0	Shallow > 12 hr	Pig	3.2	6.4	10.9	3.6	0.09	12
236-1980	1980	Winter-spring	Broadcast	None	0	Deep < 12 hr	Pig	3.2	6.4	10.9	3.6	0.09	8.4
237-1980	1980	Winter-spring	Broadcast	None	0	Deep > 12 hr	Pig	3.2	6.4	10.9	3.6	0.09	8.4

Appendix 2. Evaluation of ALFAM2 model structure

The ALFAM2 model (Hafner et al., 2019) separates applied ammonia into two pools with different emission rate constants: slow and fast (Fig. A2.1). It has been suggested by reviewers that inclusion of emission from the slow pool is an unnecessary addition that complicates the model. In fact, the structure of the model was selected to follow the pattern of emission over time observed in numerous trials: "*Emission rates from individual plots generally showed a characteristic (but highly variable) trajectory over time (Fig. 4). The initial rate was highest, and was followed by a roughly first-order decline over the first half day. After this, the rate continued to decline but much more slowly.*" (Hafner et al., 2018).

In this document, the importance of emission from the slow pool is presented by comparing model fit with and without emission from the slow pool for 100 plots randomly selected from the ALFAM2 database. Best-fit values of model parameters r_1, r_3, and f_0 were determined separately for each plot. Note that this approach is different from typical application of the ALFAM2 model; here the objective is to determine whether r_3 is necessary.

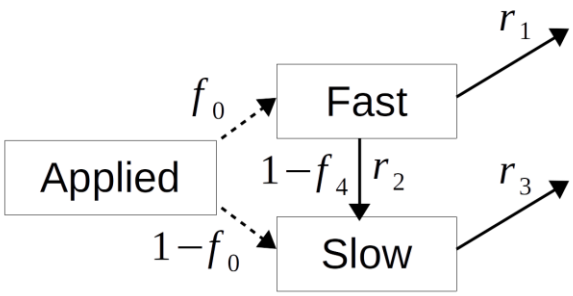


Figure A2.1. Structure of the ALFAM2 model.

In general, results show that inclusion of emission from the slow pool is necessary in order to replicate the observed trend in emission over time. This result is shown for six randomly-selected plots in Fig. A2.2, and summarized for all 100 plots in Fig. A2.3. With application of the model to longer durations (emission factors are calculated at 7 days = 168 hours), this difference would be larger. For the most accurate prediction of cumulative emission, ammonia loss from both the slow and fast pools should be included.

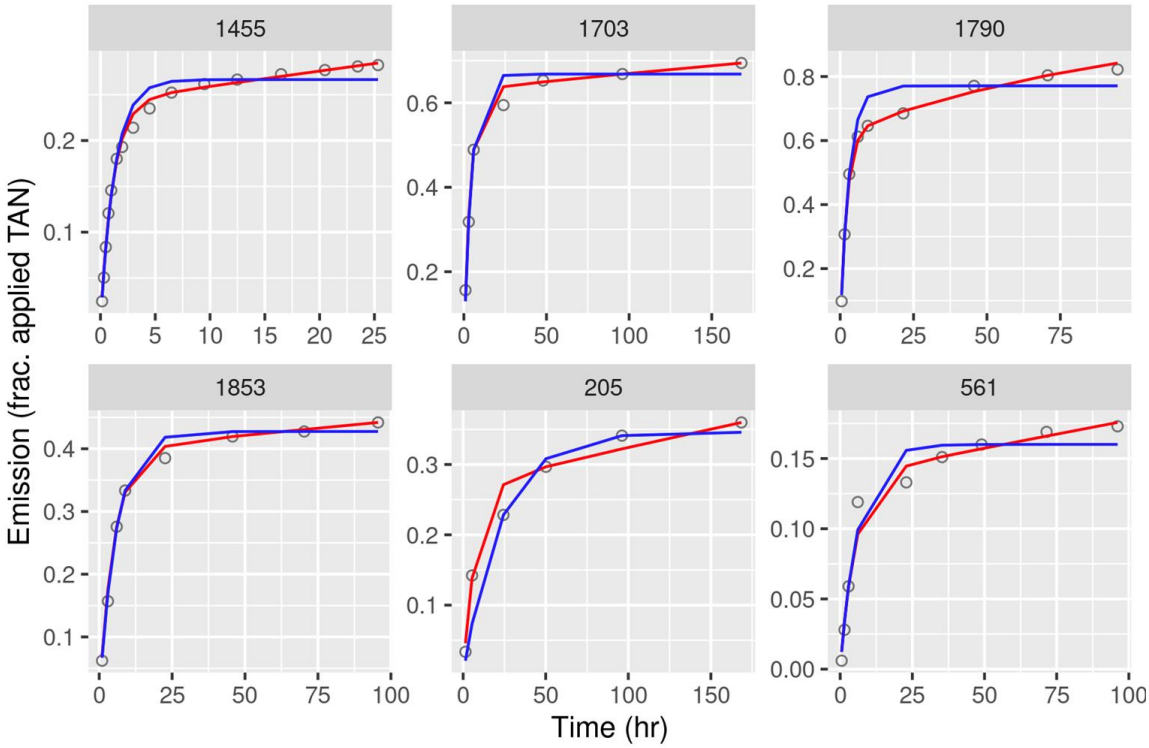


Figure A2.2. Measured cumulative emission and values calculated from plot-specific models fit with (red) and without (blue) emission from the slow pool for six randomly-selected plots.

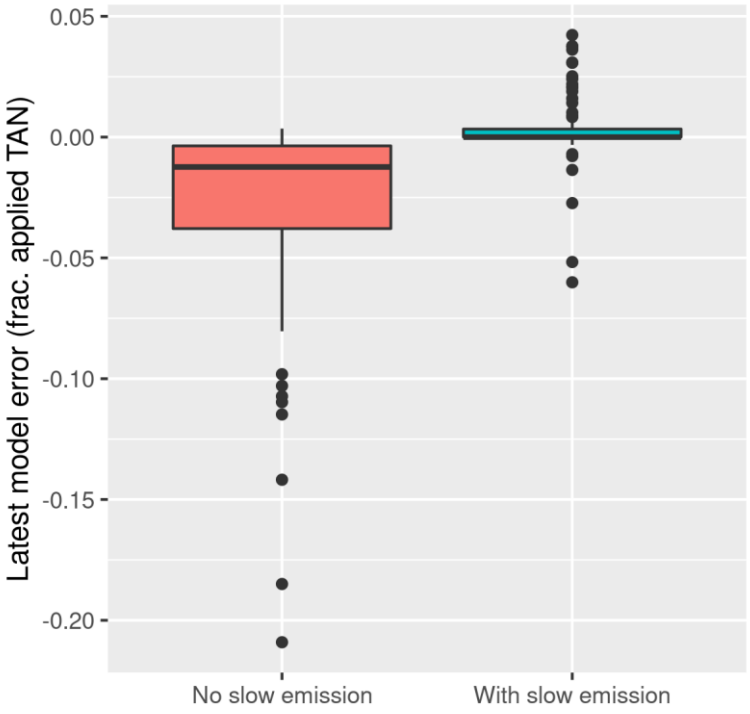


Figure A2.3. Model error in relative cumulative emission for the latest measurement interval for 100 randomly selected plots. Without emission from the slow pool, the model will tend to underestimate emission at latest durations.

Appendix 3. Model calibration

Introduction

Predictions from the ALFAM2 model depend on which secondary parameters are included, and their numeric value. For this work, a new set of parameters was developed ("set 2"), and details on calibration and the parameter values are presented here.

Calibration

The Mead-Nelder algorithm was used for parameter estimation, as in the original work (Hafner et al., 2019). The response variable used in parameter estimation was relative cumulative emission (fraction of applied TAN) for all individual intervals over the first ca. 7 days following manure application (i.e., multiple observations per plot). For parameter set 1 (i.e., in the original work (Hafner et al., 2019)) interval emission was used (kg ha^{-1}), to circumvent the problems associated with the correlation between observations that comes when using a cumulative response. However, this original approach had a tendency to slightly underestimate cumulative emission in some cases, and in general the new approach results in a better fit. Emission trials were truncated to 7 days for set 2, while in set 1 3 days (72 hours) was used. Results from the two parameter sets are compared in Section 3.1 in the report.

Weighting of observations was used as in the original work to equalize the contribution of each country to parameter estimates, with weights equal to the inverse of the number of observations from each country. However, calibration was repeated without weighting for parameter set 3, and results are compared here.

In total measurements from 648 plots were used for parameter estimation, with the majority (520) from micrometeorological measurement. Plot counts for the main dataset (449 plots) used for parameter estimation are given in Table 1.

Table A3.1. Field plot counts by country and application method for the dataset used for estimation of all parameters except those related to manure pH, incorporation, or closed slot injection. For all of these plots emission measurements were made using a micrometeorological method.

Country	Broadcast	Trailing hose	Trailing shoe	Open slot
Switzerland (CH)	27	12	5	1
Denmark (DK)	9	53	0	17
France (FR)	4	2	1	0
Ireland (IE)	8	18	23	0
The Netherlands (NL)	69	3	22	66
The United Kingdom (UK)	0	63	46	0

Estimation of parameter values related to pH and incorporation was done using subsets consisting of experiments where these variables were deliberately varied. This was done to minimize the influence of variable confounding in this effectively observational dataset. In the case of pH, the subset consisted of experiments where acidification was used, which were carried out in Denmark (150 plots) and The Netherlands (16 plots) for a total of 23 experiments from 4 institutions. This subset included results from acidification trials with wind tunnels that have not yet been added to the ALFAM2 database, but are available in the repository described in Section 5 (Johanna M. Pedersen, Aarhus University, personal communication). Measurement methods in this subset was a mix of micrometeorological and wind tunnel techniques. Because pH parameters represent a relative effect, inaccuracy of non-micrometeorological methods for absolute emission (Sommer and Misselbrook, 2016) should not be a major source of error. For this subset only, some slurry types other than cattle or pig were included.

Nearly all experiments that included incorporation were carried out in The Netherlands (Table 2). For pH and incorporation parameters, estimates of relevant secondary parameters and intercept terms were made separately for each experiment, and mean or median results among experiments were used through parameter set 2 to calculate EFs.

An additional 8 plots (4 DK with calibrated chamber measurements, 4 NL with micrometeorological measurements) with closed slot injection were used for closed slot injection parameters only. All other parameter values (not related to pH, incorporation, or closed slot injection) in parameter set 2 were estimated simultaneously, using the remainder of the observations (Table A3.1).

Table A3.2. Field plot counts by country for the dataset used for estimation of incorporation parameters.

Country	Trailing hose			Broadcast		
	None	Shallow	Deep	None	Shallow	Deep
Denmark (DK)	4	8	0	1	2	1
France (FR)	2	2	0	4	4	0
The Netherlands (NL)	0	0	0	15	25	2

Parameters and parameter values

A new set of parameter values, referred to as "set 2", was used to calculate emission factors (EFs). The original parameter values are from Hafner et al. (2019) are referred to as "set 1". An additional set, "set 3" was calculated without weighting only to evaluate the impact of weighting on parameter estimation (Section 3.2). It is compared to set 2 below but not used for calculating EFs. Values for all three sets are given in the table below (Table A3.3).

Table A3.3. Parameter values used with the ALFAM2 model to calculate emission factors for Denmark.

Primary par.	Predictor variable	Set 1	Set 2	Set 3
f_0 Initial partitioning	Intercept	-0.736	−0.606	−0.589
	Open slot injection	-1.172	−1.74	−1.86
	Closed slot injection		-7.63	
	Application rate (t ha^{-1})	-0.013	−0.0111*	−0.0111*
	Manure dry matter (%)	0.407	0.400	0.409
	Pig		−0.592	−0.593
r_1 Fast pool emission rate constant	Intercept	-1.179	−0.939	−0.940
	Broadcast application	0.628	0.794	0.921
	(Trailing shoe application)†		−0.459	−0.447
	(Cereal height (tr. shoe))†		−0.245	−0.245
	Manure dry matter (%)	-0.076	−0.14	−0.141
	Manure pH	0.533	0.665	0.665
	Air temperature (°C)	0.049	0.0735	0.0646
	Wind speed (m s^{-1})	0.049	0.15	0.174
r_2 Fast-to-slow rate constant	Intercept	-0.954	−1.80	−1.80
	Rainfall rate (mm h^{-1})	0.433	0.394	0.617
r_3 Slow pool emission rate constant	Intercept	-2.901	−3.23	−3.23
	Broadcast application		0.562	0.563
	Open slot injection	-0.123		
	Closed slot injection		−0.666	
	Shallow incorporation		−0.581	−0.581
	Deep incorporation	-0.384	−1.27	−1.27
	Manure pH	0.266	0.238	0.238
	Air temperature (°C)	0.015		
	Cum. rainfall (mm)	-0.03		
f_4 Incorporation partitioning	Shallow incorporation	-0.412	−0.965	−0.965
	Deep incorporation	-3.648	−3.69	−3.69

Notes: * This parameter does not apply to open slot injection. †These parameters were not used for calculation of emission factors because trailing shoe usage is not included in any emission factor combinations.

Appendix 4. Sensitivity

The tables below show sensitivity of predicted ammonia emission to the magnitude of predictor variables. Reference conditions were: cattle slurry with 6% DM, pH 7.5, TAN concentration of 1.2 g kg^{-1}, applied at a rate of 40 t ha^{-1} with 13°C air temperature and 2.7 m s^{-1} wind (at 2 m height), with no incorporation. In the cooling and warming scenarios, temperature changed linearly over entire duration with a range of 20 °C and a mean of 13 °C. The temperature starts high and drops in the cooling scenario, and starts low and rises in the warming scenario. The "best" scenario was defined as: cold (0°C), acidified to pH 6.0, 1% DM, deep incorporation 10 min after application.

Table A4.1. Sensitivity of predicted 7 d cumulative emission to manure properties, management, and weather, based on parameter set 2.

		Emission (fraction of applied TAN)					Reduction compared to reference (% of ref.)					Reduction compared to broadcast (%)			
ID	Description	Broadcast	Trailing hose	Trailing shoe	Open slot injection	Closed slot injection	Broadcast	Trailing hose	Trailing shoe	Open slot injection	Closed slot injection	Trailing hose	Trailing shoe	Open slot injection	Closed slot injection
1	Reference	0.48	0.30	0.26	0.16	0.021	0	0	0	0	0	37	45	66	96
2	Low DM (3%)	0.37	0.18	0.17	0.12	0.021	23	41	35	28	0.71	52	54	68	94
3	High DM (10%)	0.71	0.47	0.32	0.29	0.022	−48	−58	−22	−75	−2.9	33	55	60	97
4	Pig (vs. cattle)	0.41	0.22	0.20	0.13	0.021	14	26	24	18	0.47	46	52	68	95
5	Low application (5 t ha^{-1})	0.54	0.37	0.31	0.16	0.021	−12	−22	−20	0	0	32	41	69	96
6	High application (100 t ha^{-1})	0.41	0.22	0.19	0.16	0.021	15	28	26	0	0	47	53	60	95
7	Shallow incorp. (3 h)	0.31	0.14	0.097			36	53	63			54	68		
8	Deep incorp. (3 h)	0.25	0.084	0.039			49	72	85			66	84		
9	Shallow incorp. quick (10 min)	0.17	0.09	0.077	0.048	0.0057	64	70	71	71	73	48	56	73	97
10	Cold (0 °C)	0.45	0.2	0.14	0.13	0.021	5.6	35	47	22	0.53	57	69	72	95
11	Cool (7 °C)	0.47	0.26	0.20	0.15	0.021	1.4	12	22	7.6	0.19	44	57	68	95
12	Warm (20 °C)	0.48	0.32	0.30	0.17	0.021	−0.57	−6.3	−16	−3.9	−0.098	34	37	65	96
13	Hot (35 °C)	0.48	0.33	0.33	0.17	0.021	−0.8	−9.3	−25	−5.7	−0.14	32	32	64	96
14	Cooling	0.48	0.32	0.31	0.17	0.021	−0.66	−7.5	−19	−4.6	−0.12	33	36	65	96
15	Warming	0.47	0.25	0.2	0.15	0.021	2.9	17	22	10	0.26	46	56	69	95

		Emission (fraction of applied TAN)					Reduction compared to reference (% of ref.)					Reduction compared to broadcast (%)			
ID	Description	Broadcast	Trailing hose	Trailing shoe	Open slot injection	Closed slot injection	Broadcast	Trailing hose	Trailing shoe	Open slot injection	Closed slot injection	Trailing hose	Trailing shoe	Open slot injection	Closed slot injection
16	Still (0 m s^{-1})	0.47	0.27	0.21	0.15	0.021	1.2	11	20	6.8	0.17	44	56	68	95
17	Windy (10 m s^{-1})	0.48	0.33	0.32	0.17	0.021	−0.75	−8.7	−23	−5.3	−0.13	33	33	64	96
18	Light rain (1 mm h^{-1})	0.48	0.29	0.25	0.16	0.021	1	3.9	4	2.4	0.06	39	47	66	95
19	Moderate rain (5 mm h^{-1})	0.36	0.11	0.1	0.1	0.021	25	62	61	39	0.97	69	72	72	94
20	Heavy rain (15 mm h^{-1})	0.3	0.095	0.095	0.095	0.021	37	69	64	42	1.1	69	69	69	93
21	Acidification pH 6.4	0.37	0.19	0.13	0.1	0.012	23	36	51	39	45	48	66	73	97
22	Acidification pH 6	0.33	0.14	0.088	0.077	0.0095	32	52	66	53	56	56	73	76	97
23	Tall cereal (20 cm)	0.48	0.3	0.086	0.16	0.021	0	0	67	0	0	37	82	66	96
24	Low DM, high application, cold, still	0.33	0.11	0.1	0.11	0.021	31	62	60	36	0.9	66	69	68	94
25	High DM, low application, hot, windy	0.8	0.74	0.74	0.38	0.022	−67	−150	−180	−130	−4.9	7.4	7.5	52	97
26	High DM, low application, hot, windy, pH 6	0.76	0.72	0.71	0.35	0.011	−58	−140	−170	−110	50	4.6	6.2	54	99
27	Best	0.0098	0.0028	0.0025			98	99	99	98	98	72	74		

Table A4.2. Sensitivity of predicted 7 d emission to manure properties, management, and weather, based on non-weighted parameter set 3.

		Emission (fraction of applied TAN)				Reduction compared to reference (% of ref.)				Reduction compared to broadcast (%)		
ID	Description	Broadcast	Trailing hose	Trailing shoe	Open slot injection	Broadcast	Trailing hose	Trailing shoe	Open slot injection	Trailing hose	Trailing shoe	Open slot injection
1	Reference	0.48	0.3	0.27	0.16	0	0	0	0	37	45	67
2	Low DM (3%)	0.37	0.18	0.17	0.11	24	42	36	27	52	54	69
3	High DM (10%)	0.73	0.48	0.33	0.28	-51	-59	-23	-77	34	55	62
4	Pig (vs. cattle)	0.41	0.22	0.2	0.13	14	26	24	17	46	52	69
5	Low application (5 t ha^{-1})	0.54	0.37	0.32	0.16	-12	-21	-20	0	32	41	71
6	High application (100 t ha^{-1})	0.41	0.22	0.19	0.16	15	28	27	0	47	52	62
7	Shallow incorp. (3 h)	0.32	0.14	0.098		34	53	63		56	69	
8	Deep incorp. (3 h)	0.26	0.085	0.04		45	72	85		68	85	
9	Shallow incorp. quick (10 min)	0.18	0.091	0.078		63	70	71		50	57	
10	Cold (0 °C)	0.47	0.21	0.15	0.13	3.3	30	43	17	54	67	72
11	Cool (7 °C)	0.48	0.27	0.21	0.15	0.86	10	19	6.1	43	55	69
12	Warm (20 °C)	0.48	0.32	0.3	0.16	-0.4	-5.9	-14	-3.4	34	37	66
13	Hot (35 °C)	0.48	0.33	0.33	0.17	-0.59	-9.1	-24	-5.3	32	32	66
14	Cooling	0.48	0.32	0.31	0.16	-0.47	-7	-17	-4.1	33	36	66
15	Warming	0.47	0.26	0.21	0.14	1.8	15	20	8.5	45	55	70
16	Still (0 m s^{-1})	0.48	0.26	0.2	0.14	1.2	13	24	7.8	45	58	70
17	Windy (10 m s^{-1})	0.48	0.33	0.33	0.17	-0.58	-8.9	-23	-5.2	32	33	66
18	Light rain (1 mm h^{-1})	0.47	0.28	0.24	0.15	1.7	7.9	8.2	4.6	41	49	68
19	Moderate rain (5 mm h^{-1})	0.31	0.095	0.094	0.094	36	69	65	40	69	70	70
20	Heavy rain (15 mm h^{-1})	0.3	0.094	0.094	0.094	37	69	65	40	69	69	69
21	Acidification pH 6.4	0.38	0.19	0.13	0.095	22	36	51	39	48	66	75
22	Acidification pH 6	0.34	0.15	0.09	0.074	30	52	66	53	57	73	78

		Emission (fraction of applied TAN)				Reduction compared to reference (% of ref.)				Reduction compared to broadcast (%)		
ID	Description	Broadcast	Trailing hose	Trailing shoe	Open slot injection	Broadcast	Trailing hose	Trailing shoe	Open slot injection	Trailing hose	Trailing shoe	Open slot injection
23	Tall cereal (20 cm)	0.48	0.3	0.085	0.16	0	0	68	0	37	82	67
24	Low DM, high application, cold, still	0.33	0.12	0.1	0.1	31	62	61	34	65	69	69
25	High DM, low application, hot, windy	0.81	0.75	0.75	0.37	-68	-150	-180	-140	7	7.2	54
26	High DM, low application, hot, windy, pH 6	0.77	0.73	0.72	0.33	-59	-140	-170	-110	4.5	6.1	57
27	Best	0.01	0.0028	0.0026		98	99	99	98	72	74	

Table A4.3. Sensitivity of predicted 7 d emission to manure properties, management, and weather, based on original parameter set 1.

		Emission (fraction of applied TAN)				Reduction compared to reference (% of ref.)				Reduction compared to broadcast (%)		
ID	Description	Broadcast	Trailing hose	Trailing shoe	Open slot injection	Broadcast	Trailing hose	Trailing shoe	Open slot injection	Trailing hose	Trailing shoe	Open slot injection
1	Reference	0.38	0.29	0.29	0.19	0	0	0	0	24	24	50
2	Low DM (3%)	0.27	0.24	0.24	0.16	28	16	16	12	11	11	39
3	High DM (10%)	0.51	0.32	0.32	0.23	−35	−11	−11	−22	38	38	55
4	Pig (vs. cattle)	0.38	0.29	0.29	0.19	0	0	0	0	24	24	50
5	Low application (5 t ha^{-1})	0.44	0.32	0.32	0.21	−17	−11	−11	−11	28	28	53
6	High application (100 t ha^{-1})	0.29	0.24	0.24	0.17	23	15	15	11	17	17	43
7	Shallow incorp. (3 h)	0.34	0.25	0.25	0.17	9.2	12	12	7.7	26	26	49
8	Deep incorp. (3 h)	0.23	0.13	0.13	0.084	38	54	54	55	44	44	64
9	Shallow incorp. Quick (10 min)	0.27	0.23	0.23	0.16	28	20	20	13	15	15	40
10	Cold (0 °C)	0.23	0.16	0.16	0.11	40	45	45	42	31	31	52
11	Cool (7 °C)	0.31	0.22	0.22	0.15	18	24	24	22	29	29	53
12	Warm (20 °C)	0.45	0.38	0.38	0.24	−18	−31	−31	−30	16	16	45
13	Hot (35 °C)	0.57	0.55	0.55	0.37	−50	−90	−90	−98	3.3	3.3	34
14	Cooling	0.42	0.36	0.36	0.22	−12	−25	−25	−17	15	15	48
15	Warming	0.31	0.24	0.24	0.17	17	17	17	10	24	24	46
16	Still (0 m s^{-1})	0.36	0.27	0.27	0.18	4.6	6.3	6.3	4	25	25	50
17	Windy (10 m s^{-1})	0.41	0.34	0.34	0.21	−9.4	−19	−19	−12	18	18	49
18	Light rain (1 mm h^{-1})	0.3	0.22	0.22	0.15	21	22	22	21	26	26	50
19	Moderate rain (5 mm h^{-1})	0.078	0.074	0.074	0.056	79	74	74	70	5	5	28
20	Heavy rain (15 mm h^{-1})	0.0098	0.0098	0.0098	0.0074	97	97	97	96	0.0021	0.0021	25
21	Acidification pH 6.4	0.22	0.14	0.14	0.093	43	51	51	50	36	36	57

		Emission (fraction of applied TAN)				Reduction compared to reference (% of ref.)				Reduction compared to broadcast (%)		
ID	Description	Broadcast	Trailing hose	Trailing shoe	Open slot injection	Broadcast	Trailing hose	Trailing shoe	Open slot injection	Trailing hose	Trailing shoe	Open slot injection
22	Acidification pH 6	0.17	0.11	0.11	0.072	56	63	63	62	36	36	57
23	Tall cereal (20 cm)	0.38	0.29	0.29	0.19	0	0	0	0	24	24	50
24	Low DM, high application, cold, still	0.15	0.13	0.13	0.098	61	54	54	48	9.8	9.8	33
25	High DM, low application, hot, windy	0.86	0.82	0.82	0.64	−130	−180	−180	−240	4.8	4.8	26
26	High DM, low application, hot, windy, pH 6	0.73	0.54	0.54	0.4	−93	−88	−88	−110	26	26	45
27	Best	0.022	0.022	0.022	0.017	94	92	92	91	1.6	1.6	26

Appendix 5. Evidence of pH effects

Introduction

Manure pH is known to affect emission of ammonia through a direct relationship with free ammonia (NH_3 (aq)) activity (or concentration). However, both within and across experiments, ammonia emission does not always show the expected response to measured pH. Causes may include measurement error in pH (including a lack of standardization) or confounding variables. This topic is discussed in detail on p. 72 of Hafner et al. (2018). Therefore, it is reasonable to ask whether manure pH should be included as a predictor variable in the ALFAM2 model. This document presents the evidence for a pH effect in the ALFAM2 data used for model calibration.

Correlation

Evidence of a correlation between pH and emission is clear when acidified manure is compared to non-acidified (Fig. A5.1). However, correlation within observations without acid addition is less clear and less consistent (Fig. A5.1). Regression analysis confirmed the presence of a correlation. This result was apparent for not only acidification experiments, but also all the non-acidified data used for calibration of the model (Table A5.1). However, the magnitude of the apparent effect was much higher for acidification experiments than for non-acidified manure. This mismatch implies that natural variation in pH has a less of an effect on emission than deliberate acidification. The underlying cause is not clear, but error in pH measurement and confounding variables cannot be eliminated.

Table A5.1. Apparent effect of manure pH on ammonia emission, as coefficient for linear models. All models included application method, manure source (cattle vs. pig), manure dry matter, air temperature, and wind speed. Mixed-effects models included institution. Response variable was cumulative emission over the first 24 hours as fraction of applied TAN.

Data	Model	Coefficient and std. err. (frac. applied TAN pH^{-1})
All available	Fixed, no institution	0.028 (0.008)
All available	Mixed, institution	0.049 (0.008)
Calibration, no acid	Fixed, no institution	0.090 (0.018)
Calibration, no acid	Mixed, institution	0.045 (0.020)
Acidification experiments	Fixed, no institution	0.13 (0.015)
Acidification experiments	Mixed, institution	0.13 ((0.015)

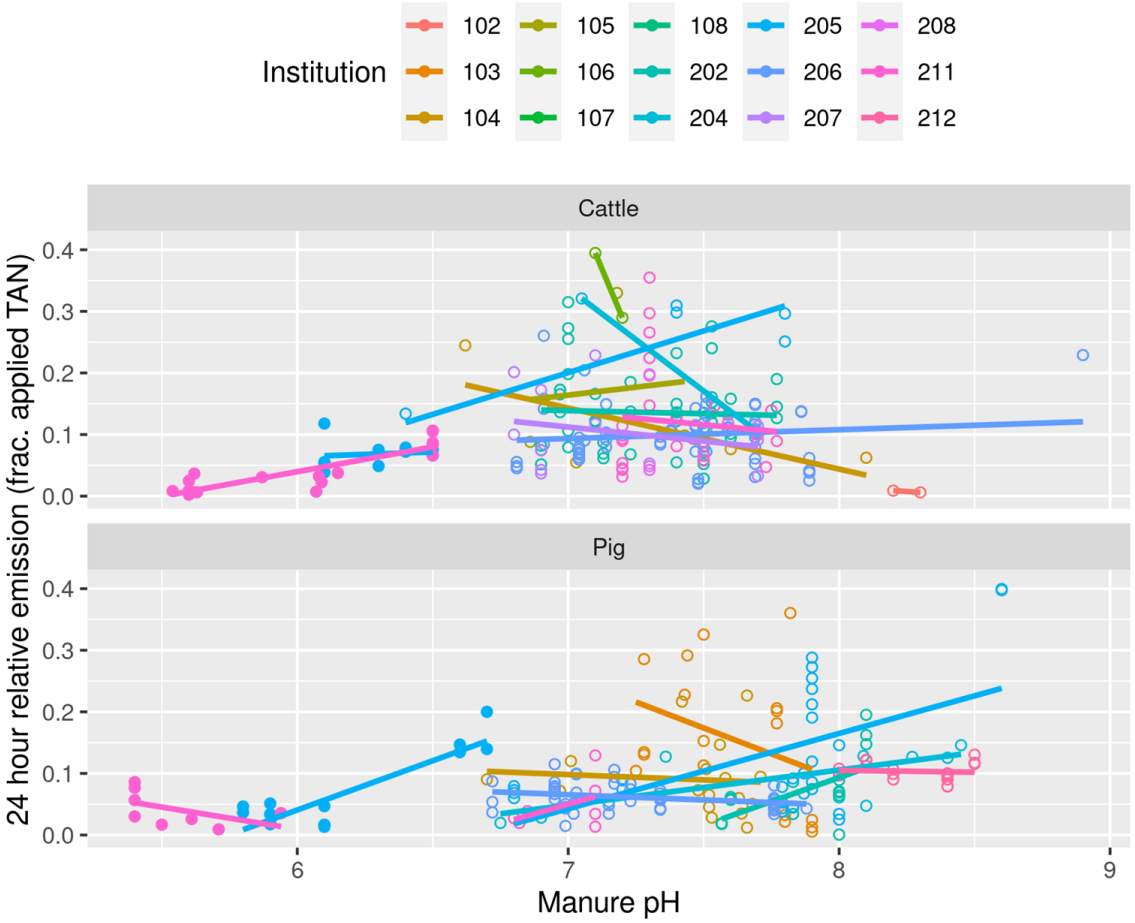


Figure A5.1. Correlation between measured cumulative emission and manure pH, based on all available data in the ALFAM2 database for trailing hose application. Filled points for acidified manure. Lines show regression results by institution and whether manure was acidified.

ALFAM2 model parameter values

Parameter values for the pH effect on r_1 and r_3 were particularly uncertain, simply because widely varying responses have been observed in different experiments (Fig. A5.2). Some of the variability may be related to manure type, with the highest effect observed for cattle manure. Median values from these experiments by manure type were used for calculating EFs (Appendix 3), and application of these values results in about a 55% reduction for cattle manure by reducing pH from 7.4 to 6.4, or about a 65% reduction by acidifying to pH 6.0 as shown in Section 3. Given the substantial uncertainty in pH parameters, the median values used here (Appendix 3) are expected to provide the most accurate estimates, but it remains likely that they will not be accurate in some cases.

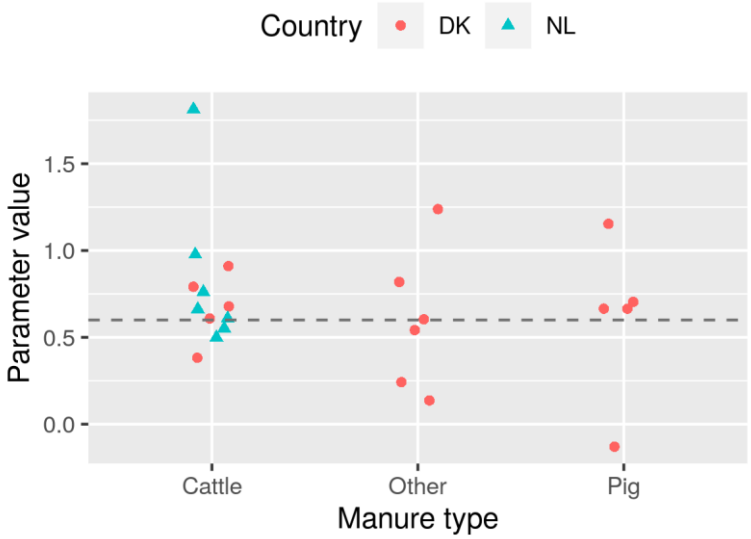


Figure A5.2. Best-fit estimates of the main secondary parameter for manure pH (for r_1, dimensionless, see (Hafner et al., 2019)) by experiment, plotted by country and manure type. Higher values mean a larger effect of pH on emission. Each experiment included at least one plot with acidified and one with untreated manure. Dashed horizontal line shows the overall median value of 0.6. Simple chemical speciation theory (neglecting soil buffering and other effects) predicts a value of 1.0, which represents a 10-fold change in r_1 per unit change in pH.

Appendix 6. Use of average weather inputs

When calculating emission factors, average weather inputs are used, as described in the report. Because the relationships between predictor variable values and emission is nonlinear in the ALFAM2 model (and any reasonably accurate model for ammonia volatilization from manure), there will be a difference between the average of many emission factors calculated using high-resolution weather data and a single emission factor calculated using average values from the same weather data. Diurnal trends of cooling and warming also contribute to a difference in the ALFAM2 model due to transfer from the fast to slow pool over time (which is meant to reflect a change in emission potential over time). This appendix presents results from a simple analysis aimed at estimating and correcting for this effect.

Seven years (2014-2020) of hourly weather data from the Foulum station were used to quantify the effect of averaging inputs. Slurry application was assumed to take place at 9.00 and 21.00 on every possible day within the dataset, and emission calculations continued for 7 days (168 h). Dry matter was assumed to be 6.5% and pH 7.0, as with cattle manure. Other variables were fixed at the centering mean levels given in the ALFAM2 paper (Hafner et al., 2019).

Because ALFAM2 database measurements, and therefore ALFAM2 model parameters, are based on averaged weather data, the use of overall average inputs was compared to 3 h averages. This interval duration was selected as a typical value that most institutes exceeded after 5-10 hours of measurement.

To address the observed difference between the two approaches, an adjustment was applied to wind speed (+15%) and air temperature (+0.9°C).

Use of average inputs tended to underestimate emission predicted with higher resolution weather data (Fig. A6.3, Table A6.1). Based on these results, the adjustments described above were applied for calculating EFs.

Table A6.1. Average cumulative emission.

Description	Mean emission (frac. applied TAN)
Average of high-resolution curves, morning	0.259
Average of high-resolution curves, night	0.241
Average of high-resolution curves, morning, no rain	0.263
Average inputs	0.227
Average inputs with adjustments	0.250

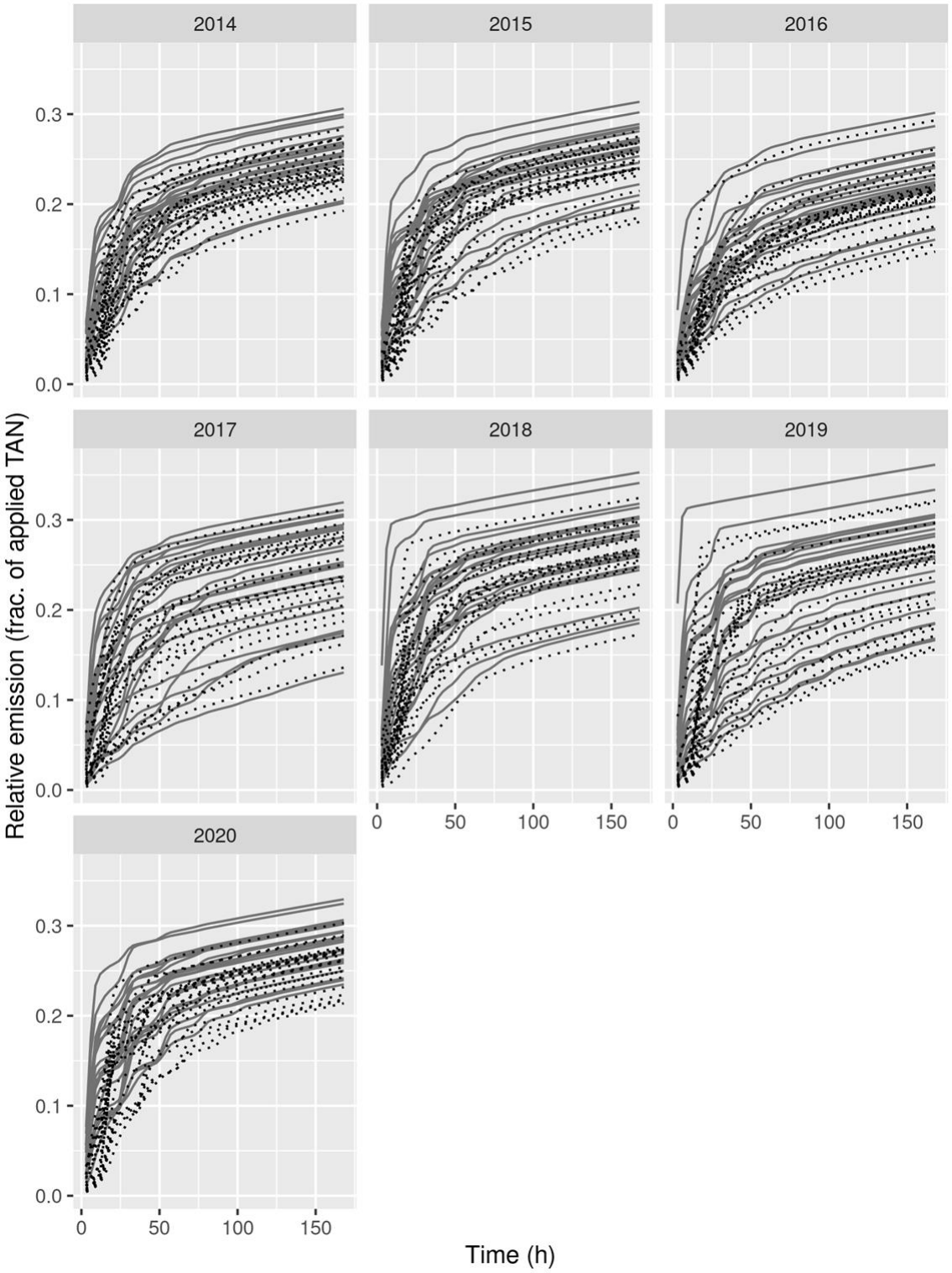


Figure A6.1. Cumulative ammonia emission calculated with the ALFAM2 as described in the text for morning (9.00, gray) or night (21.00, dotted black) application.

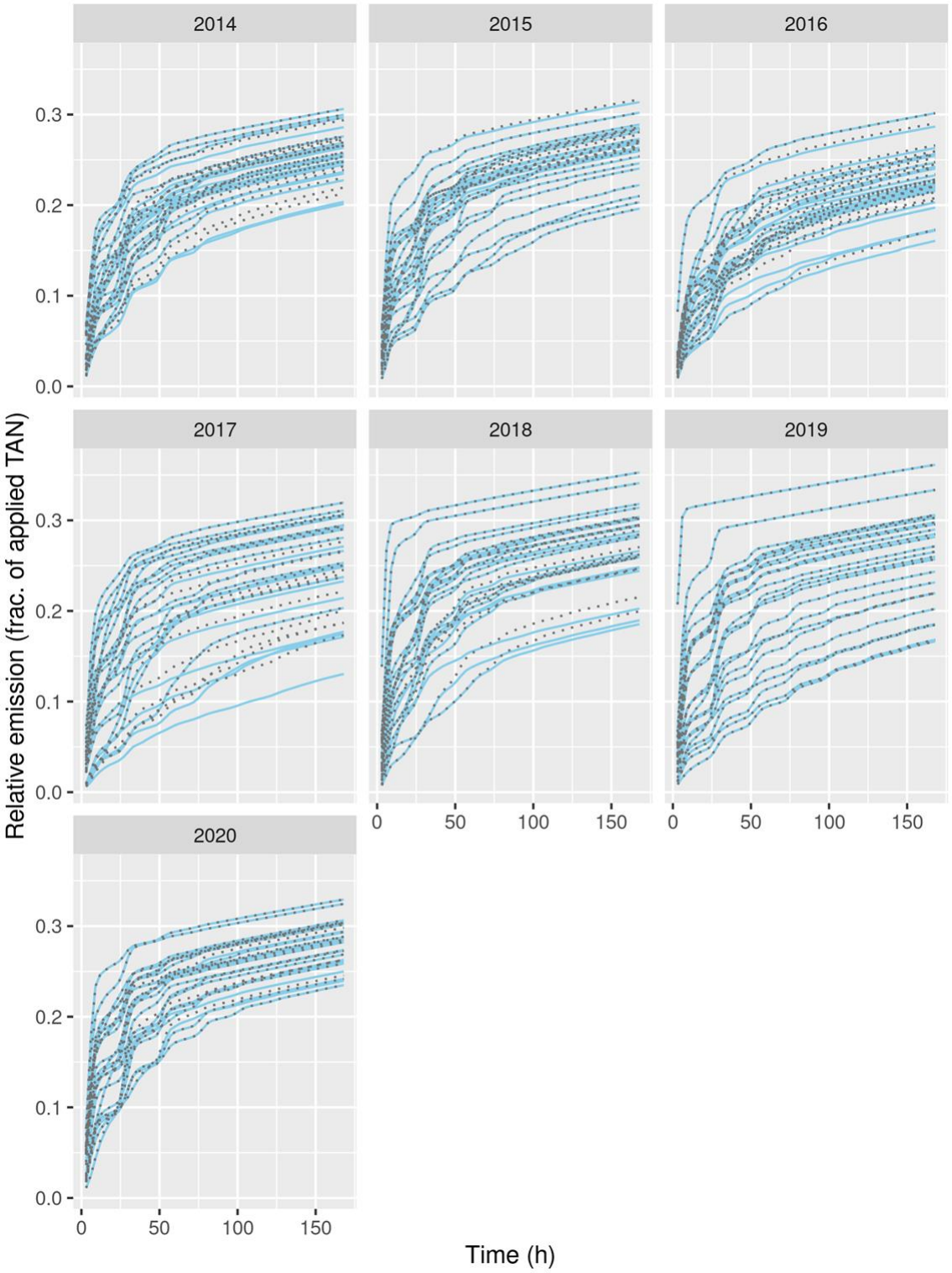


Figure A6.2. Cumulative ammonia emission calculated with the ALFAM2 as described in the text for morning application with rain (9.00, blue) or without rain (dotted gray).

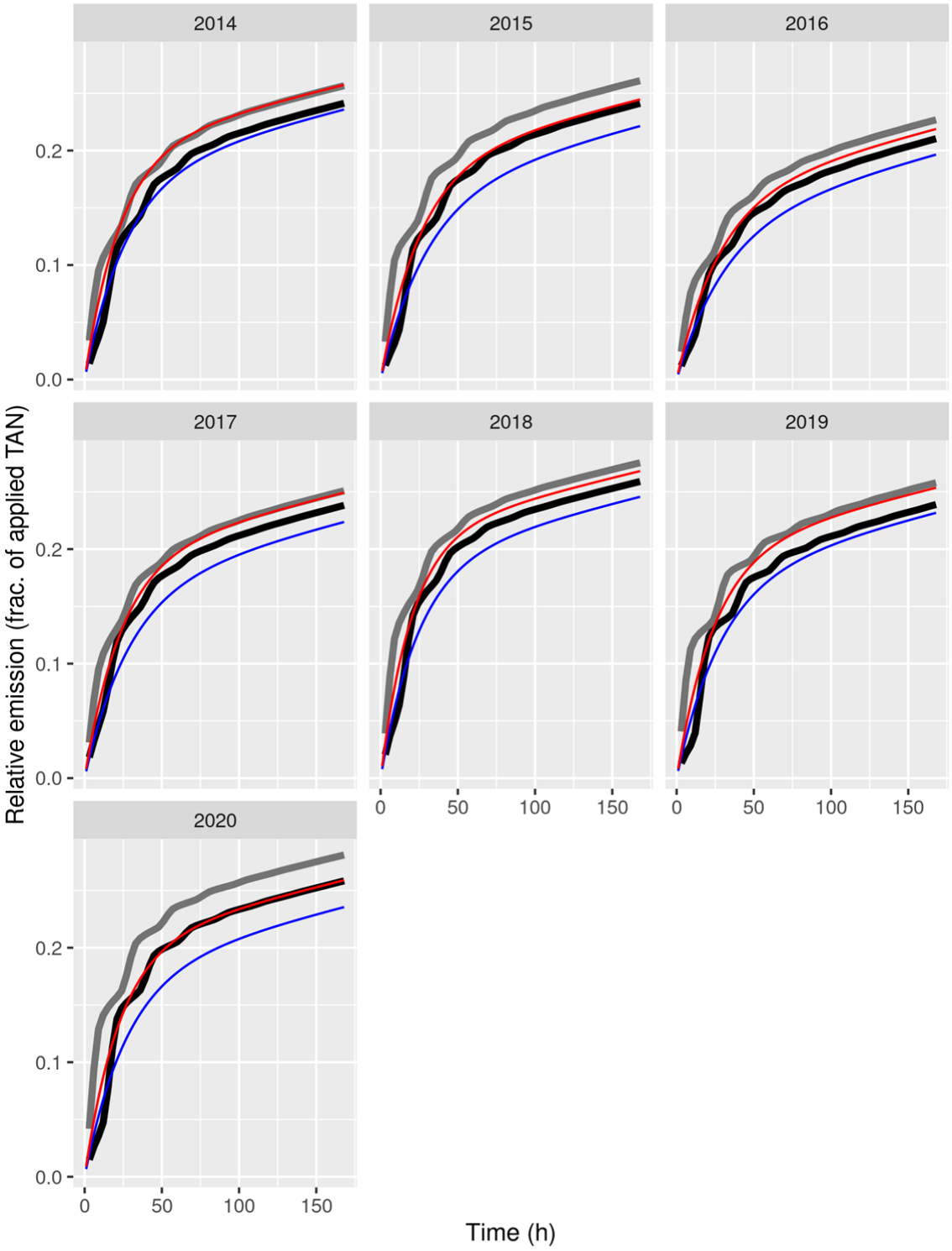


Figure A6.3. Comparison of predicted emission based on constant, average weather with (red) and without (blue) air temperature and wind speed adjustments, to averages of all emission curves for morning (gray) and night (black) application (all with rain). The red lines show the approach ultimately used for calculation of emission factors.

Appendix 7. Emission factor duration

Volatilization of ammonia from field-applied manure may continue indefinitely. However, the rate generally declines over time, and is expected to eventually reach the low background level. This pattern presents a challenge for both measurement- and model-based calculation of emission factors (EFs), which are generally meant to reflect the *total ultimate* quantity of ammonia lost. With fixed measurement sensitivity and limited budgets, field measurements end when emission rates reach some low but arbitrary level, which is not even consistent among institutions.

The ALFAM and ALFAM2 models incorporate different approaches to addressing this problem. The ALFAM model has an intrinsic limit to emission, represented by the N_{max} parameter (Søgaard et al., 2002). Estimation of EFs was simply taken as the value of this parameter, calculated from input variables. Without long-term measurements, the accuracy of this approach is unclear.

The structure of the ALFAM2 model will lead to loss of all applied TAN *eventually*, which is clearly inaccurate. As described in the paper (Hafner et al., 2019):

With first-order emission from both fast and slow pools, and loss of NH3 only through emission, the ALFAM2 model will always predict ultimate emission (as $t \rightarrow \infty$*) equal to applied TAN. In reality, plant uptake, microbial conversion, and leaching remove applied TAN from the soil/slurry system. These processes operate at longer time scales (several days) than the period when most NH3 emission is thought to occur (e.g., 48 to 72 h) (Morvan et al., 1997; Chantigny et al., 2001; Chantigny et al., 2004), and are therefore not accounted for in most* NH_3 *emission models. Given that long-term trials show that significant* NH_3 *emission continues to at least 20 days (Chantigny et al., 2004), it seems implausible to expect that "ultimate" emission can be determined from 48 or 72 h of measurements. In the interest of both simplicity and parameter estimability, this limitation is addressed in the ALFAM2 model by restricting model application to a maximum duration of 72 h (3 days) after slurry application. As with emission measurements, which cannot continue indefinitely, model predictions may significantly underestimate ultimate* NH_3 *emission in some cases. Although it is difficult to know the magnitude of this problem without more long-term trials, analysis of a large subset of the ALFAM2 database showed that the majority of total measured NH3 emission from slurry application generally occurs within 72 h (median of 98% of final emission for trials lasting 72-96 h, or 87% for trials lasting > 96 h).*

One problem with the original duration of 3 days (7 hours) is nearly guaranteed underestimation of EFs. While uncertainty in EFs cannot be completely eliminated, a longer duration can reduce underestimation. Extended durations run the risk of overestimation, especially when model duration exceeds duration of the measurements. Measurement trial duration varied among institutions in the ALFAM2 data used for model calibration (Fig. A7.1). But except for The Netherlands and Switzerland, many trials lasted more than 7 days.

To check for overestimation at later durations, apparent model error by day was calculated for each country. Average results generally showed no evidence of major overestimation at later times, or strong trends indicating an increase in error over time for trailing hose application (Fig. A7.2). Therefore, the choice of 7 days seems reasonable. However, there were trends for some particular country/application method combinations, including broadcast application in Denmark (Fig. A7.2). This pattern is not a product of model structure, but instead reflects the conflict between DK and other (FR, IE, CH, NL) broadcast measurements. It is also worth mentioning that a secondary parameter for the effect of broadcast application on r_3 is necessary to avoid a negative trend for broadcast for the bulk of measurements. For trailing hose in particular, there is no evidence of trends in model error.

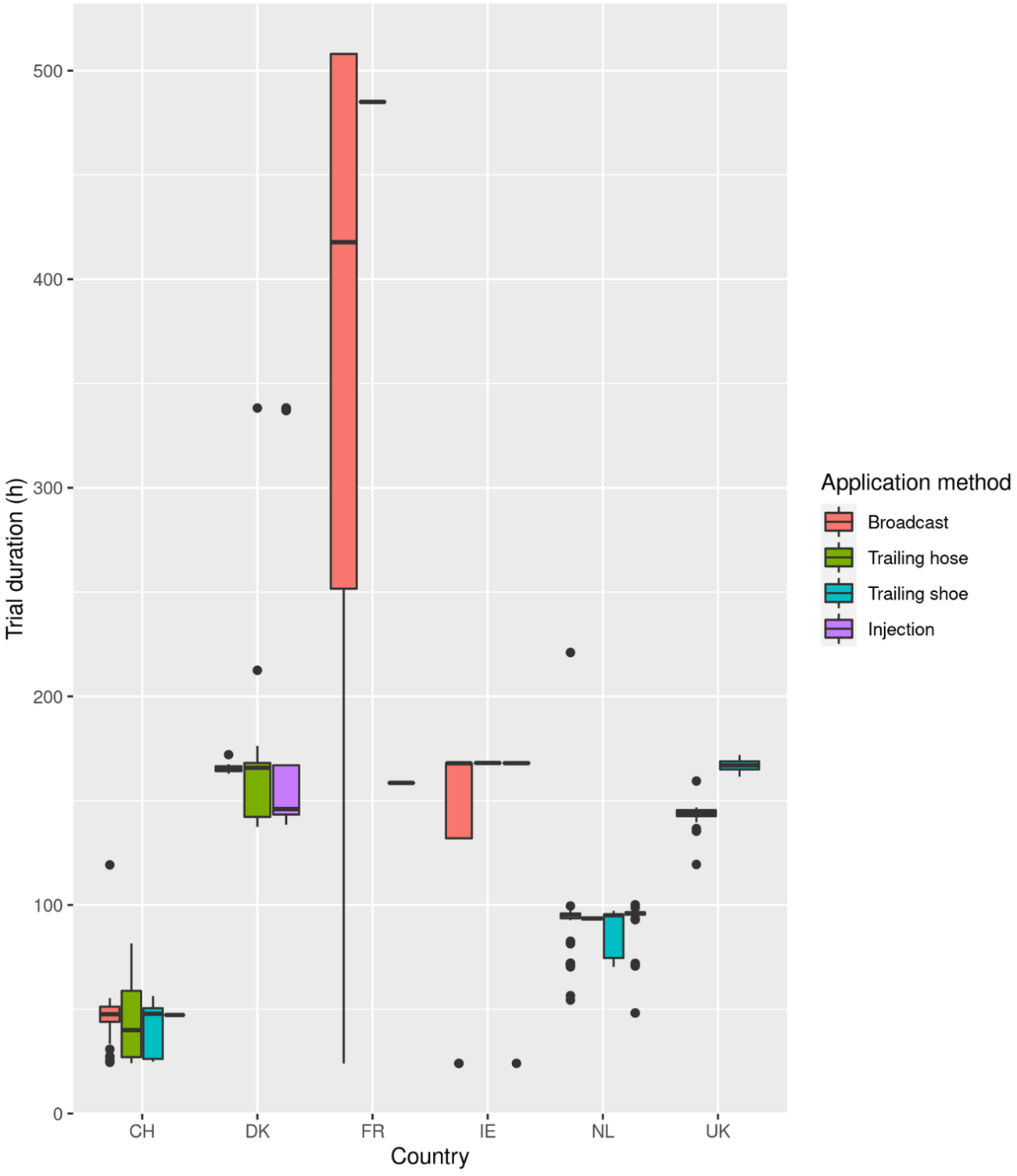


Figure A7.1. Boxplot of emission trial duration for the data used for model calibration.

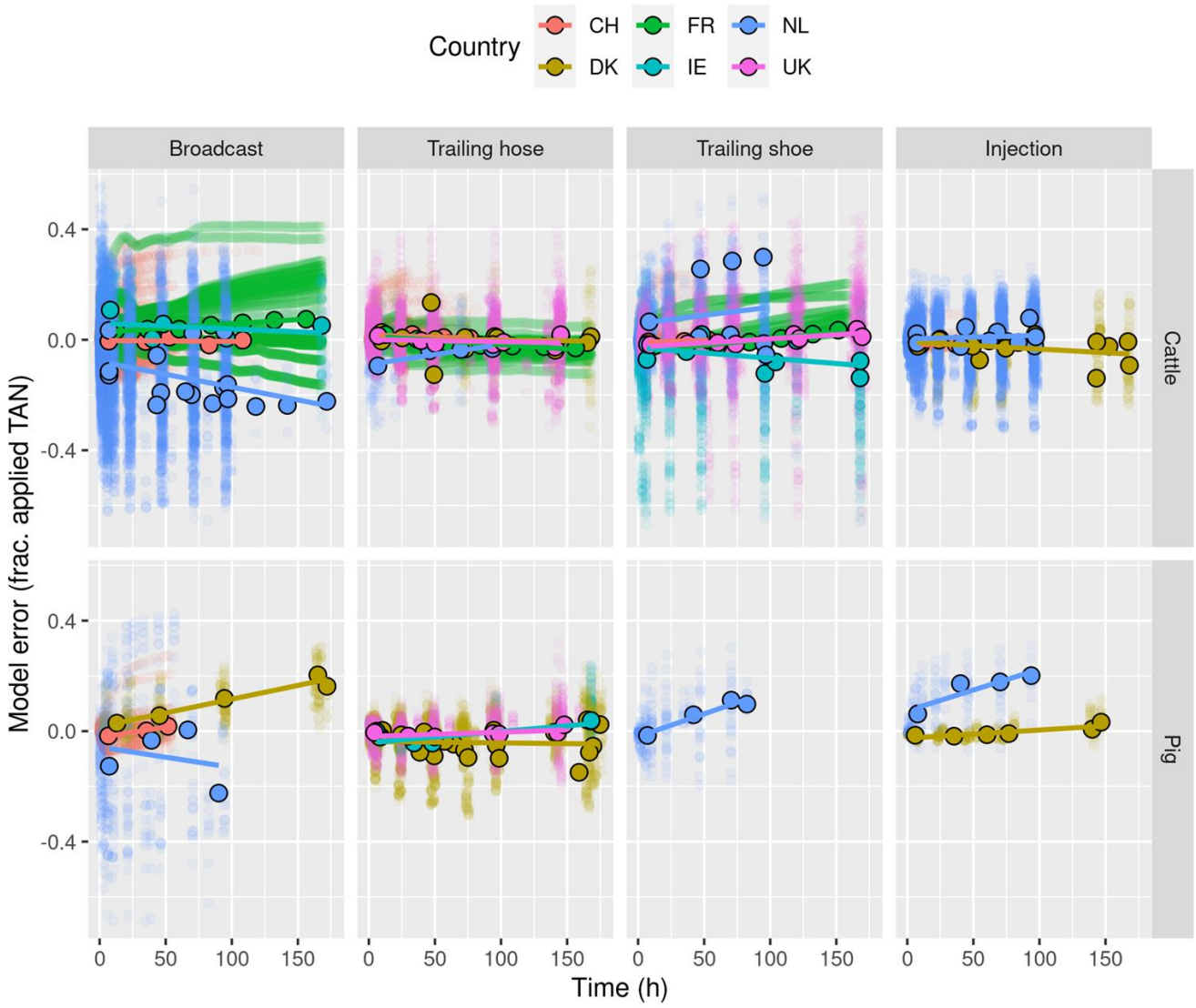


Figure A7.2. Apparent error (calculated minus measured) in ALFAM2 model calculated cumulative emission with parameter set 2 for the measurements used for calibration. Large circles show averages by day by country. Smaller semi-transparent circles show individual measurements.

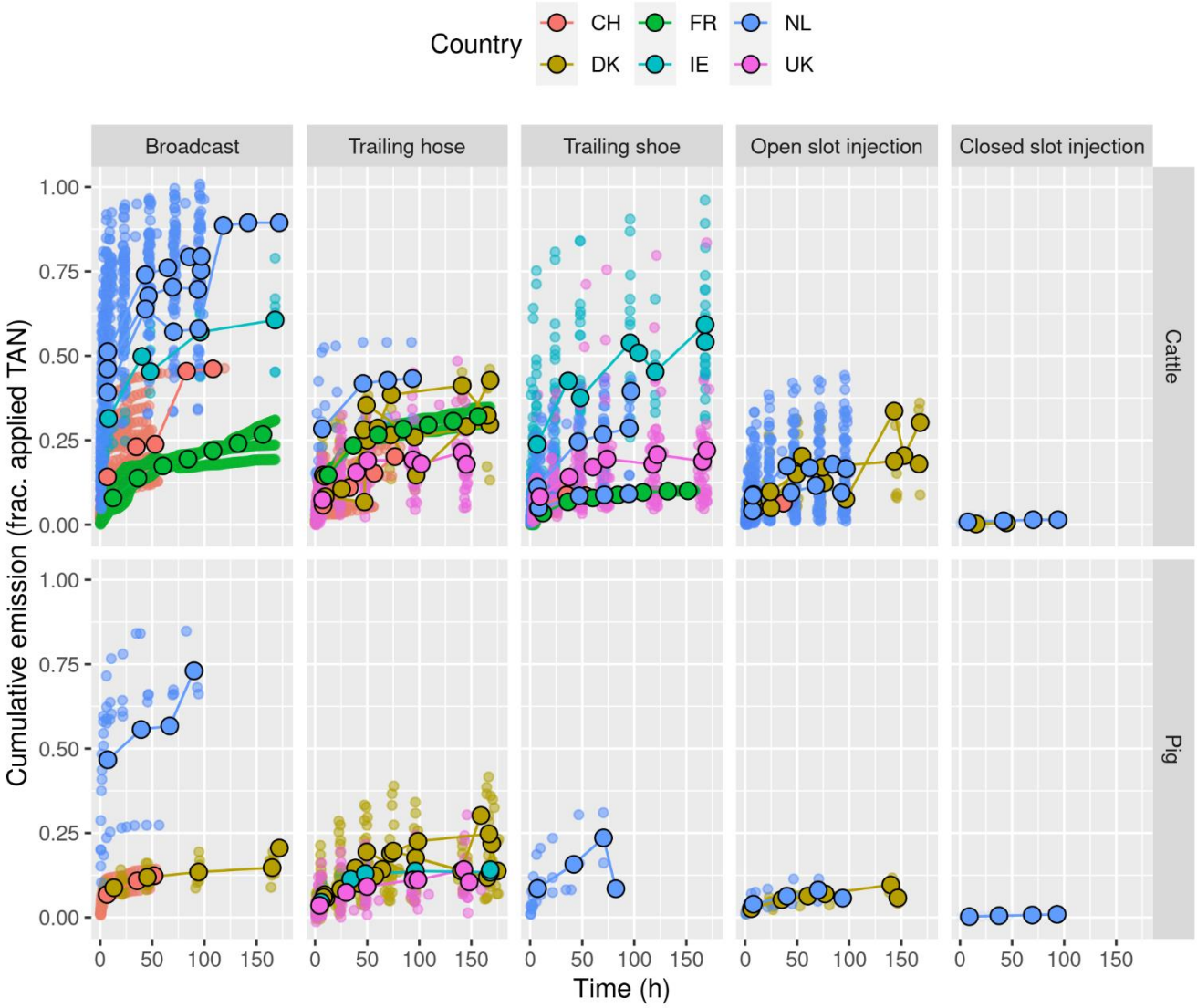


Figure A7.3. Measured cumulative emission for the measurements used for calibration. Large circles show averages by day by country. Smaller semi-transparent circles show individual measurements. Included to compare to magnitude of error shown in Fig. A7.2.

Appendix 8. Ammonia loss during liquid manure application

Liquid manure applied by broadcast application (splashplate) is thrown through the air, where it momentarily has a very high exposure to the atmosphere. Because measurement equipment is not typically installed until application is complete (there are exceptions, where measurements start prior to application, e.g., Carozzi (2013)), loss of ammonia during this short period is not included in most measurements. With trail hoses or injectors slurry does not travel through the air, so loss prior to installation of measurement equipment is small. Here a brief review of NH_3 loss during spreading is presented.

There are few studies of NH_3 emission during splash plate spreading. In the Danish study emission during spreading was determined using a mass balance method, where emission was calculated as the differences in TAN concentration in slurry samples from the tanker and from containers on the soil collecting the slurry being spread (Sommer, 1989) The measured difference were 1-4% of initial TAN with an average of 2.6% (Table 10). Emission measured this way may include NH_3 loss after application, before the collector container was closed by a lid. On the other hand, using TAN concentrations to determine loss relies on the assumption that water evaporation is negligible, and so the approach could underestimate loss. However, micrometeorological measurements also show low losses, where emission was between 0.24 and 0.4 % when applying slurry with splash plates (Misselbrook et al., 2004; Pain et al., 1989) (Table A8.1).

Emission during spreading of manure with sprinklers or rain guns with much farther travel than splash plates might be much higher, and a single study supports this. Manure lost 18% of applied TAN during sprinkler application (ca. 50 m travel) based on a mass balance approach (Rumburg et al., 2006). However rain gun application showed low losses of around 2% in another study (Misselbrook et al., 2004).

Splash plate spreading travel distance was less than 10 m in the Danish study (Sommer, 1989) and fine droplets was not formed during spreading as is seen when using rain guns. Our overall estimate of NH_3 loss during spreading is therefore 1%, which is small compared to typical broadcast EFs (Appendix 1). For trailing hose and injection, loss of NH_3 during application can be assumed to be negligible.

Table A8.1. Measurements of ammonia loss during broadcast (splash plate) or sprinkler/rain gun application of manure.

Application method	Measurement method	Spreading loss* (% applied TAN)	Source†
Splash plate	Mass balance of TAN	2.6 (1.2)	1
Splash plate	Micrometeorological	0.24 (0.07)	2
Splash plate	Micrometeorological	0.4 (0.5)	3
Rain gun (35-50 m)	Micrometeorological	2.1 (1.0)	3
Sprinkler (long range, ca. 50 m)	Mass balance of TAN	18	4

Notes: *Mean and standard deviation as percentage of applied TAN. †1. Sommer (1989), 2. Pain et al. (1989), 3. Misselbrook et al. (2004), 4. Rumburg et al. (2006)

Appendix 9. Model fit

Table A9.1. Model fit statistics for main calibration data set (no incorporation, no acidification, no closed slot injection) for ALFAM(1) and ALFAM2 models. Calculation of statistics are described elsewhere (Nash and Sutcliffe, 1970; Willmott, 1982; Willmott and Matsuura, 2005). For ALFAM2, results are shown for multiple parameter sets. Set 1 is the original parameter set (Hafner et al., 2019). Set 2 was used for calculation of emission factors. Set 3 is similar but was based on calibration without weighting. Number of observations was 449. Response variable was 7 day cumulative emission as fraction of applied TAN.

Mode/parameter set	Mean bias error	Mean absolute error	Root mean square error	Model efficiency
ALFAM(1)	0.060	0.146	0.187	0.421
2008 approach	0.064	0.147	0.186	0.426
ALFAM2 set 1	−0.038	0.134	0.183	0.442
ALFAM2 set 2	−0.017	0.107	0.15	0.625
ALFAM2 set 3	−0.016	0.105	0.149	0.634

Table A9.2. Model fit statistics for all calibration data sets from ALFAM2 database (including incorporation and acidification) for the ALFAM2 model with parameter set 2. Other details as in Table A9.1.

Application method	Number of plots	Mean bias error	Mean absolute error	Root mean square error	Model efficiency
Broadcast	170	−0.086	0.167	0.223	0.430
Trailing hose	265	−0.006	0.063	0.089	0.378
Trailing shoe	97	0.005	0.111	0.154	0.482
Open slot injection	84	0.013	0.084	0.102	0.148
Closed slot injection	8	−0.001	0.006	0.008	0.114
All methods	624	−0.024	0.101	0.148	0.621

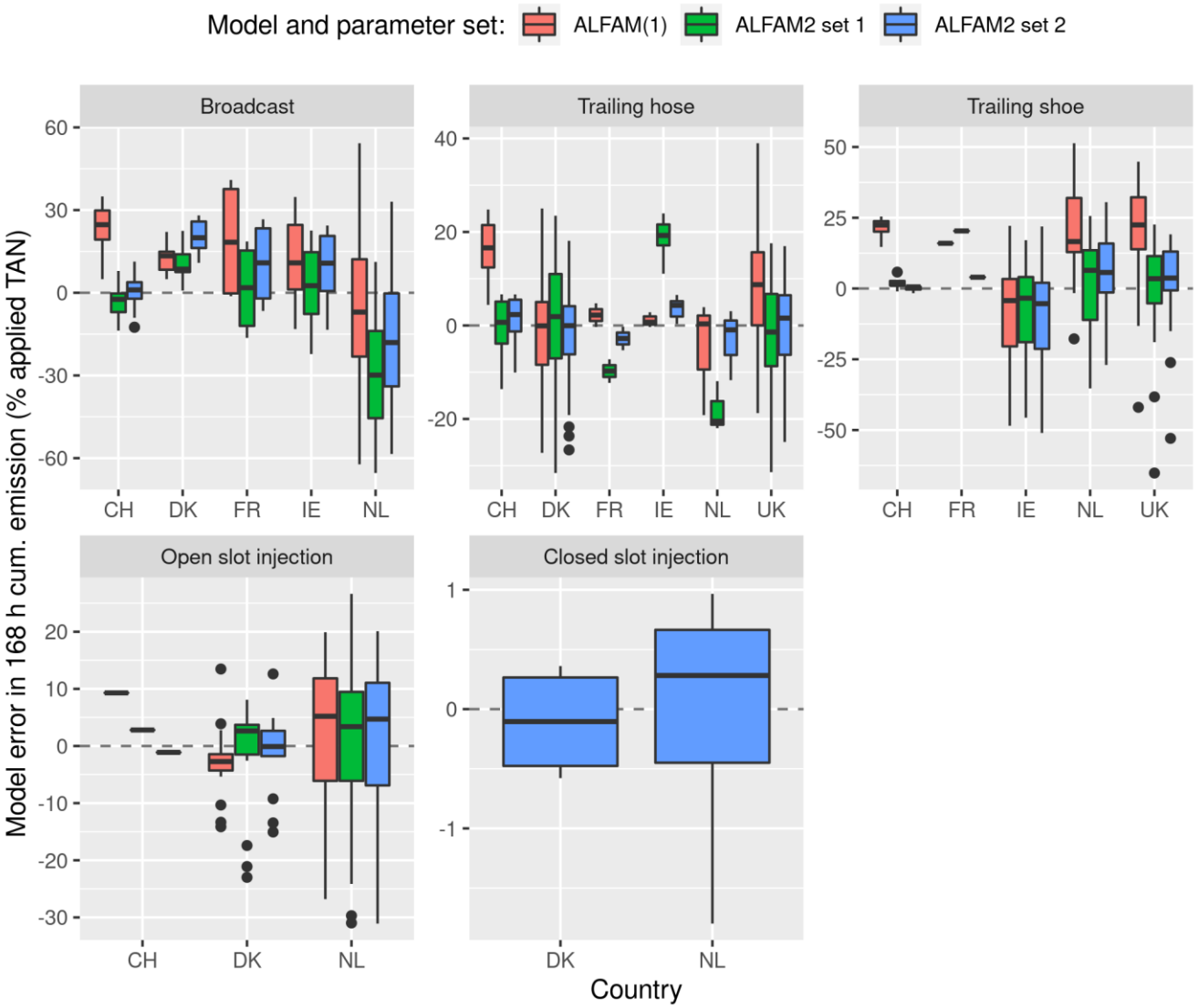


Figure A9.1. Apparent model error (calculated minus measured) in 168 h cumulative emission for the ALFAM model (Søgaard et al., 2002) and the ALFAM2 model (Hafner et al., 2019) with multiple sets of parameter values including set 1 as in Hafner et al. (2019, Table 2) and set 2 used for calculation of emission factors. Positive values indicate overestimation by the model. Boxes show 25th and 75th percentiles, heavy line show median, and whiskers show extreme value (with outliers shown as points). Observations are for main dataset used for model calibration, excluding observations with acidification or incorporation (449 plots, 8 additional plots for closed slot injection).

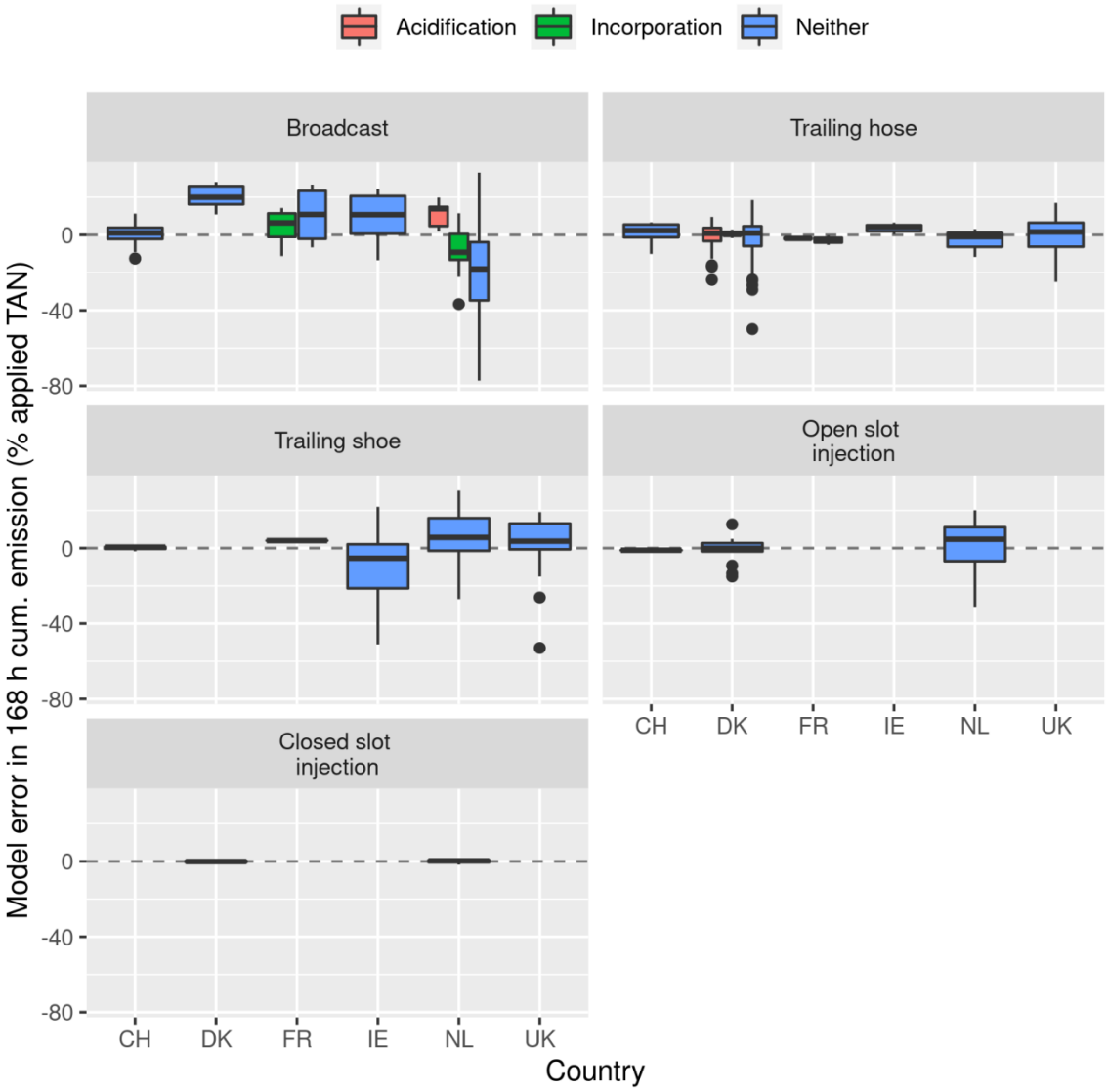


Figure A9.2. Apparent model error for the ALFAM2 model with parameter set 2, for all ALFAM2 database observations used for calibration (including incorporation and acidification, 624 plots).

Figure A9.3. Comparison of 7 d cumulative emission (fraction of applied TAN) calculated using the ALFAM2 model to measurements for showing how digestate results compare to untreated slurry. Parameters used (set 2) are given in Table 1.

Appendix 10. Differences in emission factor approaches

There are multiple reasons why new emission factors differ from those presented in 2008, as described below.

1. Current EFs were calculated using the recently developed ALFAM2 model (Hafner et al., 2019) (Section 2), while the 2008 work based EFs for trailing hose on the ALFAM model (Søgaard et al., 2002) (with major "external" calculations, see below). These models differ in several ways.

a) With respect to model structure, the ALFAM model is completely empirical, while the ALFAM2 model has some important connections to physical reality, with tracking of TAN transfer among two pools and emission rate proportional to the mass of TAN remaining. Even though predictions from the models may be aligned for some combinations of predictor variables (inputs), it is virtually impossible for them to give identical predictions for all conditions because of these differences.

b) Parameters for the ALFAM model were estimated using emission measurements in the ALFAM database, with measurements from multiple countries, made with micrometeorological, wind tunnels, or other methods. Calibration of the ALFAM2 model was based on the ALFAM2 database, which includes the original measurements and many more. There were three important differences between these datasets: for the current EFs, only micrometeorological measurements were used, a data subset showing high emission was recently found to be positively biased and was excluded (Haeni et al., 2016), and new emission measurements for cattle manure had a tendency to show lower emission. Because of advances in measurement technology in recent years, it is reasonable to expect that newer measurements (and therefore ALFAM2 results) are more accurate.

c) For ALFAM2 an observation weighting approach was used to equalize the contribution of each individual country to parameter values. In contrast, countries with more observations had a larger effect on parameter values than other countries in the ALFAM work, and these well-represented countries included one with unusually high emission measurements. However, a comparison of parameter values calculated with and without weighting (Appendix 3) shows this effect is actually quite small for ALFAM2.

2. In the 2008 work the ALFAM model was used for calculating EFs for trailing hose application only, and other EFs were determined from these results using fixed reductions for broadcast vs. trailing hose or trailing hose vs. open slot injection. Effects of incorporation were estimated by assuming emission continued after incorporation at a fixed lower rate (see Section 1 in report). In contrast, all current EFs were based on predictions from the ALFAM2 model. Therefore, while relative reductions are fixed in the 2008 EFs, they vary in the current EFs—behavior that is due to the structure of the ALFAM2 model and is thought to better represent reality.

3. The original ALFAM model is based on the Michaelis-Menten equation, with a parameter called N_{max} describing maximum cumulative emission. In the 2008 EFs, this parameter was used for EFs, which is effectively a case of extrapolation to infinite time to estimate "ultimate" emission. The accuracy of this approach is unknown. The ALFAM2 model cannot be used to predict ultimate emission (it would simply predict the loss of all TAN for very long durations), and instead EFs were calculated for a duration of 7 days (168 hours). The shape of emission curves in the ALFAM2 database suggest that the majority of emission occurs over the first few days (Hafner et al., 2018). But without many long-duration trials (perhaps > 20 days) it is difficult to determine exactly how accurate either approach really is. Regardless, this difference might be expected to lead to lower EFs with the new approach.

4. Wind speed is a predictor variable in both models. Wind speed is known to decrease as measurement height decreases. Emission factors from 2008 were based on measurements made at a 10 m height, while most measurements in the ALFAM database (from which parameter values were calculated) were from 2 m. This mismatch resulted in an overestimation of EFs. The problem was addressed for ALFAM2 and the current EFs by adjusting all wind speed measurements to 2 m.

Appendix 11. Example calculations

Here, emission factors are calculated for three conditions:

1. Pig manure applied in March by closed slot injection (ID 039-2010)
2. Cattle manure applied in April by open slot injection (ID 004-2010)
3. Cattle manure applied in summer by trailing hose, with deep incorporation after 4 hours (ID 024-2010)
4. Digestate applied by trailing hose in summer with no incorporation (ID 111-2010)
5. Barn acidified pig manure applied in late summer-autumn by broadcast (ID 169-2010)

For all, conditions for 2010-2019 were used. Input data can be found in Tables 2-4 or, more simply, in Table A1.1 in Appendix 1 by EF ID. Below, inputs and outputs with the spreadsheet model (version 2.0 or 2.1, as shown in figures below) are first shown separately for each condition, and then all together for the R model.

1. Pig manure in March

Inputs

- Pig manure
- Application rate: 30 t ha^{-1}
- DM: 3.9%
- pH: 7.2
- Closed slot injection
- Adjusted air temperature: 4.9 °C
- Adjusted wind speed: 4.02 m s^{-1}
- Rainfall rate: 0.09 mm s^{-1}

Spreadsheet model

Input variable	Input value
Slurry application (t/ha)	30
TAN concentration (kg/t)	3
Application method	Closed slot injection
Type of slurry	Pig
Slurry dry matter (%)	3.9
Slurry pH	7.2
Air temperature (°C)	4.9
Wind speed (m/s)	4.02
Rainfall rate (mm/h)	0.09
Incorporation	None
Incorporation time (h)	
Duration of emission (h)	168

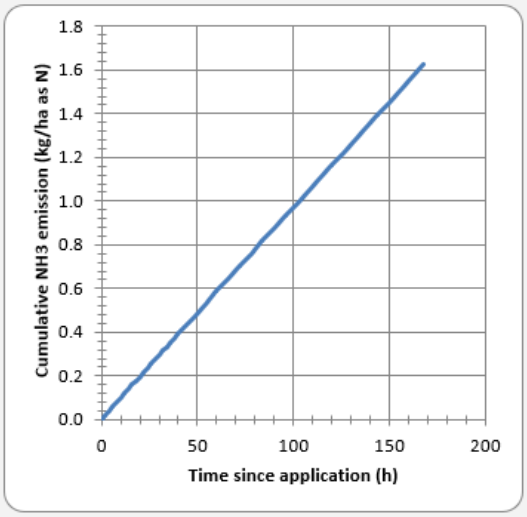
Output variable	Value
Applied TAN (kg/ha)	90.0
Cumulative emission at 168 h (kg/ha)	1.6
Cumulative emission at 168 h (%)	1.8

Messages

Typical values (and ranges)
TAN: Cattle 1 (0.5-2.5) kg/t, pig 3 (2-5) kg/t
Dry matter: Cattle 5 (1-10)%, pig 3 (1-10)%
pH: Cattle 7.2 (6.8-7.7), pig 7.5 (7.0-7.9)

Input limits
Dry matter: 0-15%
Air temperature: 0-35°C
Duration: 0-168 h (7 d)

Notes
Only change values in cells C6-C17
TAN = total ammoniacal nitrogen
For a description of the model: ALFAM2 model paper
More flexible version of model: ALFAM2 R package
For details on the ALFAM2 project: ALFAM2 project
For measurements and information: http://alfam.dk
Join the ALFAM2 mailing list: Email us
Version number: 2.0



2. Cattle manure in April

Inputs

- Cattle manure
- Application rate: 30 t ha^{-1}
- DM: 6.5%
- pH: 7.0
- Open slot injection
- Adjusted air temperature: 8.5 °C
- Adjusted wind speed: 3.91 m s^{-1}
- Rainfall rate: 0.09 mm s^{-1}

Spreadsheet model

Input variable	Input value
Slurry application (t/ha)	30
TAN concentration (kg/t)	3
Application method	Open slot injection
Type of slurry	Cattle
Slurry dry matter (%)	6.5
Slurry pH	7.0
Air temperature (°C)	8.5
Wind speed (m/s)	3.91
Rainfall rate (mm/h)	0.09
Incorporation	None
Incorporation time (h)	
Duration of emission (h)	168

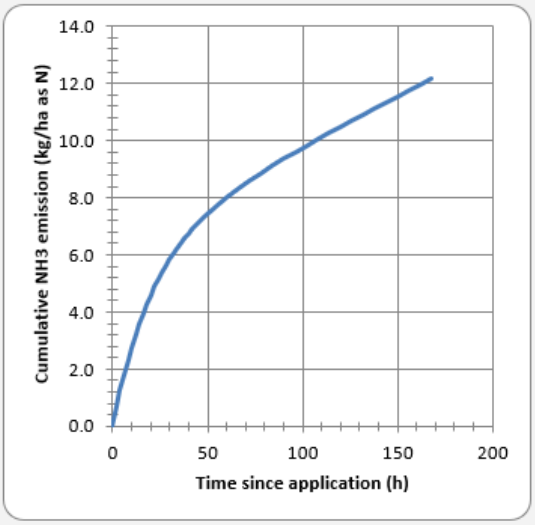
Output variable	Value
Applied TAN (kg/ha)	90.0
Cumulative emission at 168 h (kg/ha)	12.2
Cumulative emission at 168 h (%)	13.6

Messages

Typical values (and ranges)
TAN: Cattle 1 (0.5-2.5) kg/t, pig 3 (2-5) kg/t
Dry matter: Cattle 5 (1-10)%, pig 3 (1-10)%
pH: Cattle 7.2 (6.8-7.7), pig 7.5 (7.0-7.9)

Input limits
Dry matter: 0-15%
Air temperature: 0-35°C
Duration: 0-168 h (7 d)

Notes
Only change values in cells C6-C17
TAN = total ammoniacal nitrogen
For a description of the model: ALFAM2 model paper
More flexible version of model: ALFAM2 R package
For details on the ALFAM2 project: ALFAM2 project
For measurements and information: http://alfam.dk
Join the ALFAM2 mailing list: Email us
Version number: 2.0



3. Cattle manure in summer

Inputs

- Cattle manure
- Application rate: 30 t ha^{-1}
- DM: 6.5%
- pH: 7.0
- Trailing hose
- Deep incorporation after 4 hours
- Adjusted air temperature: 16.9 °C
- Adjusted wind speed: 3.18 m s^{-1}
- Rainfall rate: 0.09 mm s^{-1}

Spreadsheet model

Input variable	Input value
Slurry application (t/ha)	30
TAN concentration (kg/t)	3
Application method	Trailing hose
Type of slurry	Cattle
Slurry dry matter (%)	6.5
Slurry pH	7.0
Air temperature (°C)	16.9
Wind speed (m/s)	3.18
Rainfall rate (mm/h)	0.09
Incorporation	Deep
Incorporation time (h)	4
Duration of emission (h)	168

Output variable	Value
Applied TAN (kg/ha)	90.0
Cumulative emission at 168 h (kg/ha)	10.4
Cumulative emission at 168 h (%)	11.5

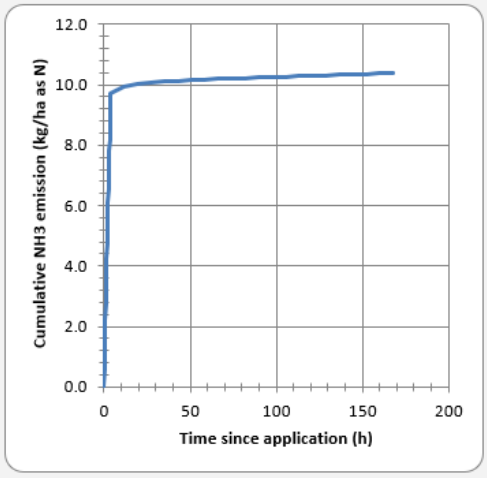
Messages

Typical values (and ranges)
TAN: Cattle 1 (0.5-2.5) kg/t, pig 3 (2-5) kg/t
Dry matter: Cattle 5 (1-10)%, pig 3 (1-10)%
pH: Cattle 7.2 (6.8-7.7), pig 7.5 (7.0-7.9)

Input limits
Dry matter: 0-15%
Air temperature: 0-35°C
Duration: 0-168 h (7 d)

Notes
Only change values in cells C6-C17
TAN = total ammoniacal nitrogen

For a description of the model:	ALFAM2 model paper
More flexible version of model:	ALFAM2 R package
For details on the ALFAM2 project:	ALFAM2 project
For measurements and information:	http://alfam.dk
Join the ALFAM2 mailing list:	Email us
Version number:	2.1



4. Digestate in summer

Inputs

- Digestate
- Application rate: 30 t ha^{-1}
- DM: 5.1%
- pH: 7.9
- Broadcast application
- Adjusted air temperature: 16.6 °C
- Adjusted wind speed: 3.22 m s^{-1}
- Rainfall rate: 0.09 mm s^{-1}

Spreadsheet model

Input variable	Input value
Slurry application (t/ha)	30
TAN concentration (kg/t)	3
Application method	Broadcast
Type of slurry	Other
Slurry dry matter (%)	5.1
Slurry pH	7.9
Air temperature (°C)	16.6
Wind speed (m/s)	3.22
Rainfall rate (mm/h)	0.09
Incorporation	None
Incorporation time (h)	
Duration of emission (h)	168

Output variable	Value
Applied TAN (kg/ha)	90.0
Cumulative emission at 168 h (kg/ha)	44.9
Cumulative emission at 168 h (%)	49.9

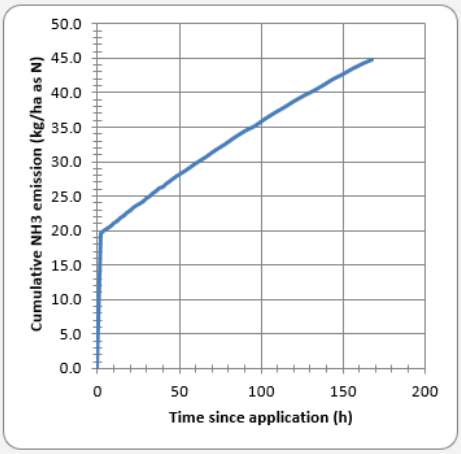
Messages

Typical values (and ranges)
TAN: Cattle 1 (0.5-2.5) kg/t, pig 3 (2-5) kg/t
Dry matter: Cattle 5 (1-10)%, pig 3 (1-10)%
pH: Cattle 7.2 (6.8-7.7), pig 7.5 (7.0-7.9)

Input limits
Dry matter: 0-15%
Air temperature: 0-35°C
Duration: 0-168 h (7 d)

Notes
Only change values in cells C6-C17
TAN = total ammoniacal nitrogen

For a description of the model:	ALFAM2 model paper
More flexible version of model:	ALFAM2 R package
For details on the ALFAM2 project:	ALFAM2 project
For measurements and information:	http://alfam.dk
Join the ALFAM2 mailing list:	Email us
Version number:	2.1

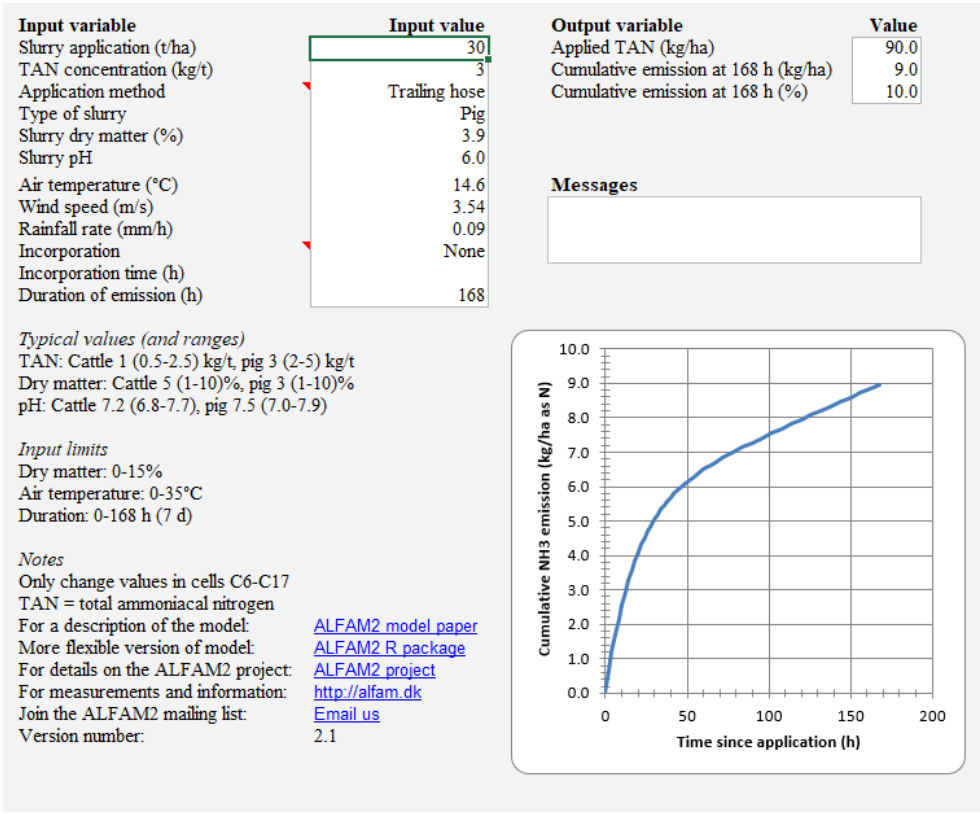


5. Acidified pig manure in autumn

Inputs

- Pig manure
- Application rate: 30 t ha^{-1}
- DM: 3.9%
- pH: 6.0
- Trailing hose application
- Adjusted air temperature: 14.6 °C
- Adjusted wind speed: 3.54 m s^{-1}
- Rainfall rate: 0.09 mm s^{-1}

Spreadsheet model



Calculation with R package

The following R code can be used to calculate the 5 example emission factors.

```
# Example calculation of emission factors

# Package
library(ALFAM2)
packageVersion('ALFAM2')

source('../functions/rounddf.R')

# Load parameters
pars <- read.csv('../model_cal/output/pars_set2.csv', row.names = 1)
pars <- as.matrix(pars)[, 1]

# Create data frame with inputs
dat <- data.frame(id = c('039-2010', '004-2010', '024-2010', '111-2010', '169-2010'),
                  ct = 168,
                  man.source.pig = c(TRUE, FALSE, FALSE, FALSE, TRUE),
                  app.rate.ni = c(0, 0, 30, 30, 30),
                  man.dm = c(3.9, 6.5, 6.5, 5.1, 3.9),
                  man.ph = c(7.2, 7.0, 7.0, 7.9, 6.0),
                  app.mthd.cs = c(TRUE, FALSE, FALSE, FALSE, FALSE),
                  app.mthd.os = c(FALSE, TRUE, FALSE, FALSE, FALSE),
                  app.mthd.bc = c(FALSE, FALSE, FALSE, TRUE, FALSE),
                  incorp.deep = c(FALSE, FALSE, TRUE, FALSE, FALSE),
                  t.incorp = c(NA, NA, 4, NA, NA),
                  air.temp = c(4.9, 8.5, 16.9, 16.6, 14.6),
                  wind.2m = c(4.02, 3.91, 3.18, 3.22, 3.45),
                  rain.rate = 0.09,
                  tan.app = 100)
```

```
preds <- ALFAM2mod(dat, pars = pars, app.name = 'tan.app', time.name = 'ct',
                   time.incorp = 't.incorp', group = 'id', warn = TRUE)

preds

write.csv(preds, 'example_EF_output.csv', row.names = FALSE)
write.csv(rounddf(preds, 2, func = signif), 'example_EF_output_rounded.csv', row.names = FALSE)
```

Resulting emission factors are shown below (Table A11.1).

Tabl1 A11.1. Emission factors calculated with the R code shown above.

ID	Emission factor (frac. applied TAN)
039-2010	0.018
004-2010	0.14
024-2010	0.12
111-2010	0.50
169-2010	0.099