Technical process description AGRAMMON
Draft

Agrammon Group

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Contents

1 Introduction

AGRAMMON is a model to simulate ammonia emission from farming. It considers livestock (housing, yard, grazing), storage, application, and plant production emissions of seven different animal categories including 26 animal species. The most common housing systems for dairy cows, cattle (tied and loose) and pigs (conventional ans label) are considered as well as several different application techniques. Ammonia emission of a single farm and of entire Switzerland can be calculated. AGRAMMON has been developed by a group of agronomists (SHL, Zollikofen), environmental scientists (Bonjour Engineering GmbH, Lostorf) and computer scientists (Oetiker+Partner AG, Olten) on behalf of the Federal Office for the Environment (FOEN, Ittigen).

The Model is availabel for calculation under `http://www.agrammon.ch`.

1.1 Structure of the model:

The model consists of computing modules, technical parameters and input parameters.

The **input parameters** include terms such as animal categories, number of animals, details on animal feeding, housing system, storage, application, and plant production. These parameters must be defined by the model users.

The **technical parameters** include terms such as emission rates, emission factors, mobilisation- and immobilisation rates of ammonia and ammonium, proportions of solid and liquid share of the manure. Further information about animal feed like the composition and the amount of the feed, the energy content, and the crude protein content are defined in this section. The technical parameters are assembled by the modellers considering the most recent research results as well as international guidelines (e.g. UNECE 2007) adopted for Switzerland. They can not be changed by the model users.

The process which calculates the ammonia emission by using the input and the technical parameters is split into four main computing modules: production (including excretion, housing, yard, grazing), storage, application, and plant production (see Figure 1). Each module is divided into a number of submodules.

Figure 1: AGRAMMON process structure: livestock, storage, application, plant production

1.2 Structure of the description:

This technical process description shows the modules and submodules, followed by the overall used input parameters and technical parameters summarised in two tables at the end the document.

Modules and submodules are designed in a standardised manner with the following sections: short description, input parameters, technical parameters, output, detailed process description. The short description gives a one line description of the module. Input parameter, technical parameter and output are listed in tables together with unit, value (tech. parameter), formula (output) and description (input and tech. parameter). The detailed process description gives additional information about the process including references.

2 Application

Agrammon Group – 2008-05-07

2.1 Short description

Computes the annual NH3 emission from application.

2.2 Input parameters

2.3 Technical parameters

2.4 Output

Parameter	Unit	Formula
n_out_application	kg N /a	Annual N flux out of the application. Val(n_into_application, Storage) - (Val(nh3_nliquid, Application::Slurry) + Val(nh3_nsolid, Application::SolidManure) + Val(nh3_npoultry, Application::PoultryManure))
nh3_napplication	kg N /a	Annual NH3 emission from manure application. Val(nh3_nliquid, Application::Slurry) + Val(nh3_nsolid, Application::SolidManure) + Val(nh3_npoultry, Application::PoultryManure)

2.5 Detailed process description

This process summarizes the contribution of the individual manure systems to the total NH3 emission from manure application.

2.5.1 Differences to DYNAMO

The categories "Soil absorptive" and "application before rain" are omitted since the practice is unknown and experimental results are not available (according to the decision of the steering group from 02/07/2007).

The distinction between the categories incorporation of solid manure by chisel plough or plough are omitted since the difference is unclear (according to the decision of the steering group from 02/07/2007).

The category "rapid incorporation" is replaced by "application manure" since slurry is hardly incorporated in Switzerland. The entire category is adapted to UNECE (2007) including new categories.

3 Application::PoultryManure

Agrammon Group – 2008-03-30

3.1 Short description

Computes the annual NH3 emission from poultry manure application.

3.2 Input parameters

3.3 Technical parameters

Parameter	Value	Unit	Description
er_App_manure_layers-_growers_other_poultry	0.65	-	Emission rate for manure application. The average rate has been derived from Frick et al. (1996) and Menzi et al. (1996). The value is based on the average emissions from diffrent Swiss experiments. Emission based on TAN of slurry.
er_App_manure_turkeys-_broilers	0.3	-	Emission rate for manure application. The average rate has been derived from Frick et al. (1996) and Menzi et al. (1996). The value is based on the average emissions from diffrent Swiss experiments. Emission based on TAN of slurry.
TAN_share_solid	0.5	-	Share of TAN in applied solid manure.

3.4 Output

Parameter	Unit	Formula
nh3_npoultry_turkeys_broilers	kg N /a	NH3 emission from solid manure application. Tech(er_App_manure_turkeys_broilers) * Tech(TAN_share_solid) * Val(n_into_application_poultryManure_turkeys_broilers, ::Storage) * Val(c_incorp_time, PoultryManure::CincorpTime) * Val(c_season, SolidManure::Cseason);
n_frompoultry	kg N /a	N flux out of solid manure application. Val(n_into_application_poultryManure, ::Storage) - Out(nh3_npoultry);
nh3_npoultry_layers_growers-_other_poultry	kg N /a	NH3 emission from solid manure application. Tech(er_App_manure_layers_growers_other_poultry) * Tech(TAN_share_solid) * Val(n_into_application_poultryManure_layers_growers_other_poultry, ::Storage) * Val(c_incorp_time, PoultryManure::CincorpTime) * Val(c_season, SolidManure::Cseason);
nh3_npoultry	kg N /a	NH3 emission from solid manure application. Out(nh3_npoultry_layers_growers_other_poultry) + Out(nh3_npoultry_turkeys_broilers);

3.5 Detailed process description

This process computes the annual average NH3 emission from poultry manure application. The standard emission factor is corrected according to the TAN content and the application rate, the application technology, the crops to which the manure is applied, respected soft measures during application and the application season, the time lag between application and incorporation, the incorporation technology used, and the proportion of solid manure that is applied on hot days.

The correction factor are based on the same input parameters as the application for solid manure.

3.5.1 References:

Menzi H, Keller M, Katz P, Fahrni M, Neftel A 1997. Ammoniakverluste nach der Anwendung von Mist. Agrarforschung 4:328-331.

Menzi H, Katz P, Frick R, Fahrni M, Keller M 1997: Ammonia emissions following the application of solid manure to grassland. In: Jarvis S.C. and Pain B.F. (Eds.): "Nitrogen Emissions from Grassland", CAB, 265-274.

4 Application::PoultryManure::CincorpTime

Agrammon Group – 2008-05-02

4.1 Short description

Correction factor taking into account the time lag between application and incorporation of the poultry manure.

4.2 Input parameters

4.3 Technical parameters

Parameter	Value	Unit	Description
eff_inc_lw1h	-0.95	-	Reduction due to incorporation of solid manure within 1 hour. UNECE (2007).
eff_inc_lw4h	-0.8	-	Reduction due to incorporation of solid manure within 4 hours. Empirical estimate deduced from UNECE (2007). Mean value between the category incorporation within 1 hour and incorporation within 8 hours.
eff_inc_lw8h	-0.7	-	Reduction due to incorporation of solid manure within 8 hours. Values adapted from UNECE (2007) (category Incorporation by plough within 12 h)
eff_inc_lw1d	-0.55	-	Reduction due to incorporation of solid manure within 1 day. Values adapted from UNECE (2007) Empirical estimate deduced from Menzi et al. (1997).
eff_inc_lw3d	-0.3	-	Reduction due to incorporation of solid manure within 3 days. Empirical estimate deduced from Menzi et al. (1997).
eff_inc_gt3d	-0.1	-	Reduction due to incorporation of solid manure after 3 days Empirical estimate deduced from Menzi et al. (1997).
eff_inc_none	0.0	-	Basis with no incorporation of solid manure.

4.4 Output

Parameter	Unit	Formula
c_incorp_time	-	Correction factor taking into account the time lag between application and incorporation of the solid manure. 1 + (Val('incorp_lw1h','..::SolidManure::CincorpTime') * Tech('eff_inc_lw1h') + Val('incorp_lw4h','..::SolidManure::CincorpTime') * Tech('eff_inc_lw4h') + Val('incorp_lw8h','..::SolidManure::CincorpTime') * Tech('eff_inc_lw8h') + Val('incorp_lw1d','..::SolidManure::CincorpTime') * Tech('eff_inc_lw1d') + Val('incorp_lw3d','..::SolidManure::CincorpTime') * Tech('eff_inc_lw3d') + Val('incorp_gt3d','..::SolidManure::CincorpTime') * Tech('eff_inc_gt3d') + Val('incorp_none','..::SolidManure::CincorpTime') * Tech('eff_inc_none'));

4.5 Detailed process description

This process computes the correction factor for the time lag between application and incorporation of the poultry manure.

4.5.1 References:

Menzi H, Keller M, Katz P, Fahrni M, Neftel A 1997. Ammoniakverluste nach der Anwendung von Mist. Agrarforschung 4:328-331.

Menzi H, Katz P, Frick R, Fahrni M, Keller M 1997: Ammonia emissions following the application of solid manure to grassland. In: Jarvis S.C. and Pain B.F. (Eds.): "Nitrogen Emissions from Grassland", CAB, 265-274.

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. ECE/EB.AIR/WG.5/2007/13.

5 Application::Slurry

Agrammon Group – 2008-05-07

5.1 Short description

Computes the annual NH3 emission from slurry application.

5.2 Input parameters

5.3 Technical parameters

Parameter	Value	Unit	Description
er_App_cattle_liquid	0.5	-	Emission rate for slurry application based on TAN of the slurry. The average rate has been derived from Sommer et al (2001b), Sogaard et al (2002), Menzi et al (1998), Menzi et al (1997a)
er_App_pigs_liquid	0.4	-	Emission rate for slurry application based on TAN of the slurry. The average rate has been derived from Sogaard et al (2002)

5.4 Output

Parameter	Unit	Formula

er_App_liquid	-	Emission rate for slurry application based on TAN of the slurry. The average rate has been derived from Sommer et al (2001b), Sogaard et al (2002), Menzi et al (1998), Menzi et al (1997a) and Sogaard et al (2002)
		
		if(Val(n_into_storage_liquid, ::Livestock) != 0){ return (Val(n_into_storage_liquid_pigs, ::Livestock) * Tech(er_App_pigs_liquid) + (Val(n_into_storage_liquid, ::Livestock) - Val(n_into_storage_liquid_pigs, ::Livestock)) * Tech(er_App_cattle_liquid)) / Val(n_into_storage_liquid, ::Livestock) }else{ return (Tech(er_App_cattle_liquid) + Tech(er_App_pigs_liquid))/2;
		};

n_remain_liquid	kg N /a	Annual total N remaining on the field from slurry application. Val(n_into_application_liquid, ::Storage) - Out(nh3_nliquid);
nh3_nliquid	kg N /a	Total annual NH3 emission from slurry application. Val(tan_into_application_liquid, ::Storage) * (Out(er_App_liquid) + Val(c_app, Slurry::Applrate)) * Val(c_tech, Slurry::Ctech) * Val(c_soft, Slurry::Csoft) * Val(c_season, Slurry::Cseason);
tan_remain_liquid	kg N /a	Annual N as TAN remaining on field the from slurry/liquid application. Val(tan_into_application_liquid, ::Storage) - Out(nh3_nliquid);

5.5 Detailed process description

This process computes the annual NH3 emission from slurry application. The standard emission factor for slurry application is corrected according to the TAN content and the application rate, the application technology, the crops to which the manure is applied, soft measures applied during application and the application season.

Since slurry is hardly incorporated in Switzerland, no correction for incorporeation was made for slurry application.

5.5.1 References:

Frick R, Menzi H, Katz P 1996. Ammoniakverluste nach der Hofdüngeranwendung. FAT-Bericht Nr. 486.

Menzi H, Frick R, Kaufmann R 1997a. Ammoniak-Emissionen in der Schweiz: Ausmass und technische Beurteilung des Reduktionspotentials. Eidgenössische Forschungsanstalt für Agrarökologie und Landbau, Zürich-Reckenholz. 107pp.

Katz P.E. 1996. Dissertation: Ammoniakemissionen nach der Gülleanwendung auf Grünland. Diss. ETH Nr. 11382. Dissertation. Eidgenössische Technische Hochschule Zürich.

6 Application::Slurry::Applrate

Agrammon Group – 2008-05-01

6.1 Short description

Correction factor taking into account the slurry application rate per ha and the TAN content of the slurry as compared to the emission rate occurring with a standard application rate of 30 m3 and a TAN content of 1.15 kg N /m3.

6.2 Input parameters

Parameter	Unit	Description
dilution_parts_water	1:x	Specific slurry dilution. TAN contents have been calculated based on a standard dilution of 1:1 with a TAN content of 1.15 kg N /m3.
appl_rate	m3 /ha	Application rate, mean volume of slurry applied on a ha per deployment.

6.3 Technical parameters

Parameter	Value	Unit	Description
norm_er	0.5	-	Standard emission of 50% of the applied TAN calculated based on an equation published by Menzi et al (1998) using a TAN standard of 1.15 kg /m3 for an 1:1 dilution, with application rate (AR) standard of 30 m3 /ha and average swiss meteorological conditions: ((19.41 * TAN_standard + 4.02 * 1.15 - 9.51) * (0.0214 * ARstandard + 0.36) / (AR_standard * TAN-standard)))

6.4 Output

Parameter	Unit	Formula
TAN_content	-	TAN content of the slurry compared to the emission rate occuring with a standard application rate of 30 m3 and a TAN content of 1.15 kg N /m3. 2.3*(1/(ln(dilution_parts_water)+1))
c_app	-	Correction factor taking into account the slurry application rate per ha and the TAN content of the slurry. (((19.41 * Out(TAN_content) + 4.02 * 1.15 - 9.51) * (ln(appl_rate) * 0.0214 + 0.36)) / (ln(appl_rate) * Out(TAN_content)) - Tech(norm_er));

6.5 Detailed process description

This process computes the correction factor as a function of the application rate and the TAN content of the slurry. The equation has been described by Menzi et al (1998). The correction factor is calculated based on the slurry application rate per ha and the TAN content of the slurry compared to the emission rate occurring with a standard application rate of 30 m3 and a TAN content of 1.15 kg N /m3.

6.5.1 References:

Menzi H, Katz, PE, Fahrni M, Neftel A, Frick R 1998. A simple empirical model based on regression analysis to estimate ammonia emissions after manure application. Atmospheric Environment 32:301-307.

7 Application::Slurry::Cseason

Agrammon Group – 2008-05-06

7.1 Short description

Correction factor of the standard emission rate of the season for slurry application.

7.2 Input parameters

Parameter	Unit	Description
appl_summer	%	Share of slurry applied June to August.
appl_autumn_winter_spring	%	Share of slurry applied September to May.

7.3 Technical parameters

Parameter	Value	Unit	Description
c_summer	0.15	-	Correction factor for the application of slurry in summer (June to August): Model calculation according to the model of Katz (Menzi et al. 1997b) with meteorological data from Liebefeld 1993-2002: average from March to November 12Â°C, 70% relative air humidity, 1.15 kg/m3 TAN, 30 m3/ha resulting in a loss of 50.6% TAN; summer 17.8Â°C resulting in a loss of 56.7% TAN (+12%). Value chosen for cal-culation: +15%
c_autumn_winter_spring	-0.05	-	Correction factor for the application of slurry in autumn, winter and spring (Sept to May): Model calculation according to the model of Katz (Menzi et al. 1997b) with meteorological data from Liebefeld 1993-2002: average from March to November 12Â°C, 70% relative air humidity, 1.15 kg/m3 TAN, 30 m3/ha resulting in a loss of 50.6% TAN; spring/autumn/winter 9Â°C resulting in a loss of 48.1% TAN (-4.8%). Value chosen for calculation: -5%

7.4 Output

Parameter	Unit	Formula

appl_autumn_winter_spring	-	.
		
		 if (In(appl_autumn_winter_spring) > 1) { return (In(appl_autumn_winter_spring)/100);
		 }else{ return (In(appl_autumn_winter_spring));
		 };

appl_summer	-	.
		
		 if (In(appl_summer) > 1) { return (In(appl_summer)/100);
		 }else{ return (In(appl_summer));
		 };

c_season	-	Correction factor of the standard emission rate depending on season of application. (1 + (Out(appl_summer) * Tech(c_summer) + Out(appl_autumn_winter_spring) * Tech(c_autumn_winter_spring)));

7.5 Detailed process description

This process computes the correction factor for the seasons the slurry is applied.

7.5.1 References:

Menzi H, Frick R, Kaufmann R 1997. Ammoniak-Emissionen in der Schweiz: Ausmass und technische Beurteilung des Reduktionspotentials. Eidgenössische Forschungsanstalt für Agrarökologie und Landbau, Zürich-Reckenholz. 107pp.

Frick R, Menzi H 1997. Hofdüngeranwendung: Wie Ammoniakverluste vermindern? Auch einfache Massnahmen wirken. FAT Bericht Nr. 496.

8 Application::Slurry::Csoft

Agrammon Group – 2008-04-22

8.1 Short description

Correction factor of the standard emission rate if different kind of "soft measures" are respected/applied.

8.2 Input parameters

Parameter	Unit	Description
appl_evening	%	Share of slurry applied in the evening after 18:00.
appl_hotdays	-	Proportion of slurry applied on hot days. Possible values: `never`, `rarely`, `sometimes`, `frequently`

8.3 Technical parameters

Parameter	Value	Unit	Description
c_evening	-0.2	-	Correction factor of the emission rate if slurry is applied in the evening (after 18h)(Menzi et al 1997; Frick and Menzi 1997). Assumption based on a single experiment with an application after 18h in August at a temperature of >20Â°C: reduction of the emission by 38%, the reduction of the emission averaged over the whole year is only 50%, i.e. -0.2 The correction is omitted for solid manure since infiltration into soil does not occur.
c_hotdays_frequently	0.1	-	Correction factor of the emission rate if slurry is applied frequently on hot days. Loss calculated according to the model of Katz (Menzi et al. 1997b) at 17Â°C (i.e. +5Â°C) compared to the reference temperature of 12Â°C (other parameters: 70% rela-tive air humidity, 1.15 kg/m3 TAN, 30 m3/ha) resulting in a loss of 19.22 kg N/ha at 17 Â°C and 55.7% TAN, respectively (compared to 17.45 kg N/ha and 50.6% TAN at 12Â°C, respectively) which corresponds to an increase of 10.1% (rounded to 10%).
c_hotdays_sometimes	0.0	-	Correction factor of the emission rate if slurry is applied sometimes on hot days (estimation based on Menzi et al (1997)).
c_hotdays_rarely	-0.1	-	Correction factor of the emission rate if slurry is applied rarely on hot days (estimation based on Menzi et al (1997)).
c_hotdays_never	-0.2	-	Correction factor of the emission rate if slurry is applied never on hot days (estimation based on Menzi et al (1997)).

8.4 Output

Parameter	Unit	Formula

c_hotdays	-	Correction factor of the emission rate if slurry is applied on hot days.
		
		my $key = "c_hotdays_" . In(appl_hotdays);
		return Tech($key);

c_soft	-	Correction factor of the emission rate if slurry is applied by considering different kinds of "soft measures".
		
		if (In(appl_evening) > 1) { return (1 + ((In(appl_evening)/100) * Tech(c_evening) + Out(c_hotdays)));
		} else { return (1 + (In(appl_evening) * Tech(c_evening) + Out(c_hotdays)));
		};

8.5 Detailed process description

This process computes the correction factor if different soft measures for slurry application are respected.

8.5.1 References:

Menzi H, Frick R, Kaufmann R 1997. Ammoniak-Emissionen in der Schweiz: Ausmass und technische Beurteilung des Reduktionspotentials. Eidgenössische Forschungsanstalt für Agrarökologie und Landbau, Zürich-Reckenholz. 107pp.

Frick R, Menzi H 1997. Hofdüngeranwendung: Wie Ammoniakverluste vermindern? Auch einfache Massnahmen wirken. FAT Bericht Nr. 496.

9 Application::Slurry::Ctech

Agrammon Group – 2008-05-01

9.1 Short description

Computes the correction factor depending on the slurry application technology used.

9.2 Input parameters

Parameter	Unit	Description
share_splash_plate	%	Share of slurry applied with splash plate.
share_trailing_hose	%	Share of slurry applied with trailing hose.
share_trailing_shoe	%	Share of slurry applied with trailing shoes.
share_shallow_injection	%	Share of slurry applied with shallow injection.
share_deep_injection	%	Share of slurry applied with deep injection.

9.3 Technical parameters

Parameter	Value	Unit	Description
red_splash_plate	0.0	-	There is no reduction for broadcasting with splash plate as to this way of applying slurry all the other methods are compared to.
red_trailing_hose	-0.3	-	Reduction efficiency as compared to broadcasting applying trailing hose. Adopted from UNECE (2007), Frick and Menzi (1997) and Menzi et al. (1997).
red_trailing_shoe	-0.5	-	Reduction efficiency as compared to broadcasting applying trailing shoe. Adopted from UNECE (2007), Frick and Menzi (1997) and Menzi et al. (1997).
red_shallow_injection	-0.7	-	Reduction efficiency as compared to broadcasting applying shallow injection. Adopted from UNECE (2007), Frick and Menzi (1997) and Menzi et al. (1997).
red_deep_injection	-0.8	-	Reduction efficiency as compared to broadcasting applying deep injection. Adopted from UNECE(2007), Frick and Menzi (1997) and Menzi et al. (1997).

9.4 Output

Parameter	Unit	Formula

share_shallow_injection	-	Share
		
		if (In(share_shallow_injection) > 1) { return (In(share_shallow_injection)/100);
		}else{ return (In(share_shallow_injection));
		};

share_deep_injection	-	Share
		
		if (In(share_deep_injection) > 1) { return (In(share_deep_injection)/100);
		}else{ return (In(share_deep_injection));
		};

share_splash_plate	-	Share
		
		if (In(share_splash_plate) > 1) { return (In(share_splash_plate)/100);
		}else{ return (In(share_splash_plate));
		};

share_trailing_shoe	-	Share
		
		if (In(share_trailing_shoe) > 1) { return (In(share_trailing_shoe)/100);
		}else{ return (In(share_trailing_shoe));
		};

c_tech	-	Reduction factor for the emission due to the used application technology as compared to broadcasting. 1 + (Out(share_deep_injection) * Tech(red_deep_injection) + Out(share_shallow_injection) * Tech(red_shallow_injection) + Out(share_trailing_shoe) * Tech(red_trailing_shoe) + Out(share_trailing_hose) * Tech(red_trailing_hose) + Out(share_splash_plate) * Tech(red_splash_plate));

share_trailing_hose	-	Share
		
		if (In(share_trailing_hose) > 1) { return (In(share_trailing_hose)/100);
		}else{ return (In(share_trailing_hose));
		};

9.5 Detailed process description

This process computes the correction factor according to the technology used for the slurry application.

9.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. UNECE executive body for the convention on long-range transboundary air pollution, Working Group on Strategies and Review, EB.AIR/WH.5/2007/13/ 16 July 2007, Genf. 35p.

Frick R, Menzi H 1997. Hofdüngeranwendung: Wie Ammoniakverluste vermindern? Auch einfache Massnahmen wirken. FAT Bericht 496.

Menzi H, Frick R, Kaufmann R 1997. Ammoniak-Emissionen in der Schweiz: Ausmass und technische Beurteilung des Reduktionspotentials. Eidgenössische Forschungsanstalt für Agrarökologie und Landbau, Zürich-Reckenholz. 107pp.

10 Application::SolidManure

Agrammon Group – 2008-03-30

10.1 Short description

Computes the annual NH3 emission from solid manure application.
Attention: simplified model based on total N output from storage!!!

10.2 Input parameters

10.3 Technical parameters

Parameter	Value	Unit	Description
er_App_manure_dairycows-_cattle_pigs	0.8	-	Emission rate for manure application. The average rate has been derived from Frick et al. (1996) and Menzi et al. (1996). The value is based on the average emissions from diffrent Swiss experiments. Emission based on TAN of slurry.
er_App_manure_horses-_otherequides_smallruminants	0.7	-	Emission rate for manure application. The average rate has been derived from Frick et al. (1996) and Menzi et al. (1996). The value is based on the average emissions from diffrent Swiss experiments. Emission based on TAN of slurry.
TAN_share_solid	0.5	-	Share of TAN in applied solid manure.

10.4 Output

Parameter	Unit	Formula
nh3_nsolid_horses-_otherequides_smallruminants	kg N /a	NH3 emission from solid manure application. Tech(er_App_manure_horses_otherequides_smallruminants) * Tech(TAN_share_solid) * Val(n_into_application_manure_horses_otherequides_smallruminants, ::Storage) * Val(c_incorp_time, SolidManure::CincorpTime) * Val(c_season, SolidManure::Cseason);
nh3_nsolid_dairycows_cattle-_pigs	kg N /a	NH3 emission from solid manure application. Tech(er_App_manure_dairycows_cattle_pigs) * Tech(TAN_share_solid) * Val(n_into_application_manure_dairycows_cattle_pigs, ::Storage) * Val(c_incorp_time, SolidManure::CincorpTime) * Val(c_season, SolidManure::Cseason);
nh3_nsolid	kg N /a	NH3 emission from solid manure application. Out(nh3_nsolid_dairycows_cattle_pigs) + Out(nh3_nsolid_horses_otherequides_smallruminants);
n_fromsolid	kg N /a	N flux out of solid manure application. Val(n_into_application_manure, ::Storage) - Out(nh3_nsolid);

10.5 Detailed process description

This process computes the annual average NH3 emission from solid manure application (liquid/solid and deep litter). The standard emission factor is corrected according to the TAN content and the application rate, the application technology, the crops to which the manure is applied, respected soft measures during application and the application season, the time lag between application and incorporation, the incorporation technology used, and the proportion of solid manure that is applied on hot days.

10.5.1 References:

Menzi H, Keller M, Katz P, Fahrni M, Neftel A 1997. Ammoniakverluste nach der Anwendung von Mist. Agrarforschung 4:328-331.

Menzi H, Katz P, Frick R, Fahrni M, Keller M 1997: Ammonia emissions following the application of solid manure to grassland. In: Jarvis S.C. and Pain B.F. (Eds.): "Nitrogen Emissions from Grassland", CAB, 265-274.

11 Application::SolidManure::CincorpTime

Agrammon Group – 2008-05-02

11.1 Short description

Correction factor taking into account the time lag between application and incorporation of the solid manure.

11.2 Input parameters

Parameter	Unit	Description
incorp_lw1h	%	Share of incorporated solid manure within 1 hour.
incorp_lw4h	%	Share of incorporated solid manure within 4 hours.
incorp_lw8h	%	Share of incorporated solid manure within 8 hours.
incorp_lw1d	%	Share of incorporated solid manure within 1 day.
incorp_lw3d	%	Share of incorporated solid manure within 3 days.
incorp_gt3d	%	Share of incorporated solid manure after 3 days.
incorp_none	%	Share of solid manure not incorporated.

11.3 Technical parameters

Parameter	Value	Unit	Description
eff_inc_lw1h	-0.9	-	Reduction due to incorporation of solid manure within 1 hour. UNECE (2007).
eff_inc_lw4h	-0.7	-	Reduction due to incorporation of solid manure within 4 hours. Empirical estimate deduced from UNECE (2007). Mean value between the category incorporation within 1 hour and incorporation within 8 hours.
eff_inc_lw8h	-0.5	-	Reduction due to incorporation of solid manure within 8 hours. Values adapted from UNECE (2007) (category Incorporation by plough within 12 h)
eff_inc_lw1d	-0.35	-	Reduction due to incorporation of solid manure within 1 day. Values adapted from UNECE (2007) Empirical estimate deduced from Menzi et al. (1997).
eff_inc_lw3d	-0.3	-	Reduction due to incorporation of solid manure within 3 days. Empirical estimate deduced from Menzi et al. (1997).
eff_inc_gt3d	-0.1	-	Reduction due to incorporation of solid manure after 3 days Empirical estimate deduced from Menzi et al. (1997).
eff_inc_none	0.0	-	Basis with no incorporation of solid manure.

11.4 Output

Parameter	Unit	Formula
c_incorp_time	-	Correction factor taking into account the time lag between application and incorporation of the solid manure. 1 + (Out(incorp_lw1h) * Tech(eff_inc_lw1h) + Out(incorp_lw4h) * Tech(eff_inc_lw4h) + Out(incorp_lw8h) * Tech(eff_inc_lw8h) + Out(incorp_lw1d) * Tech(eff_inc_lw1d) + Out(incorp_lw3d) * Tech(eff_inc_lw3d) + Out(incorp_gt3d) * Tech(eff_inc_gt3d) + Out(incorp_none) * Tech(eff_inc_none));

incorp_lw1d	-	Share of incorporated solid manure within 1 day.
		
		if (In(incorp_lw1d) > 1) { return (In(incorp_lw1d)/100) } else { return (In(incorp_lw1d));
		};

incorp_lw3d	-	Share of incorporated solid manure within 3 days.
		
		if (In(incorp_lw3d) > 1) { return (In(incorp_lw3d)/100) } else { return (In(incorp_lw3d));
		};

incorp_none	-	Share of not-incorporated solid manure.
		
		if (In(incorp_none) > 1) { return (In(incorp_none)/100) } else { return (In(incorp_none));
		};

incorp_lw4h	-	Share of incorporated solid manure within 4 hour.
		
		if (In(incorp_lw4h) > 1) { return (In(incorp_lw4h)/100) } else { return (In(incorp_lw4h));
		};

incorp_lw1h	-	Share of incorporated solid manure within 1 hour.
		
		if (In(incorp_lw1h) > 1) { return (In(incorp_lw1h)/100) } else { return (In(incorp_lw1h));
		};

incorp_lw8h	-	Share of incorporated solid manure within 8 hour.
		
		if (In(incorp_lw8h) > 1) { return (In(incorp_lw8h)/100) } else { return (In(incorp_lw8h));
		};

incorp_gt3d	-	Share of incorporated solid manure after 3 days.
		
		if (In(incorp_gt3d) > 1) { return (In(incorp_gt3d)/100) } else { return (In(incorp_gt3d));
		};

11.5 Detailed process description

This process computes the correction factor for the time lag between application and incorporation of the solid manure.

11.5.1 References:

Menzi H, Keller M, Katz P, Fahrni M, Neftel A 1997. Ammoniakverluste nach der Anwendung von Mist. Agrarforschung 4:328-331.

12 Application::SolidManure::Cseason

Agrammon Group – 2008-05-06

12.1 Short description

Correction factor of the standard emission rate of the season for solid manure application.

12.2 Input parameters

Parameter	Unit	Description
appl_summer	%	Share of solid manure applied June to August.
appl_autumn_winter_spring	%	Share of solid manure applied September to May.

12.3 Technical parameters

Parameter	Value	Unit	Description
c_summer	0.15	-	Correction factor for the application of solid manure in summer (June to August): Model calculation according to the model of Katz (Menzi et al. 1997b) with meteorological data from Liebefeld 1993-2002: average from March to November 12Â°C, 70% relative air humidity, 1.15 kg/m3 TAN, 30 m3/ha resulting in a loss of 50.6% TAN; summer 17.8Â°C resulting in a loss of 56.7% TAN (+12%). Value chosen for cal-culation: +15%.
c_autumn_winter_spring	-0.05	-	Correction factor for the application of solid manure in autumn, winter and spring (Sept to May): Model calculation according to the model of Katz (Menzi et al. 1997b) with meteorological data from Liebefeld 1993-2002: average from March to November 12Â°C, 70% relative air humidity, 1.15 kg/m3 TAN, 30 m3/ha resulting in a loss of 50.6% TAN; spring/autumn/winter 9Â°C resulting in a loss of 48.1% TAN (-4.8%). Value chosen for calculation: -5%.

12.4 Output

Parameter	Unit	Formula

appl_autumn_winter_spring	-	.
		
		 if (In(appl_autumn_winter_spring) > 1) { return (In(appl_autumn_winter_spring)/100);
		}else{ return (In(appl_autumn_winter_spring));
		};

appl_summer	-	.
		
		 if (In(appl_summer) > 1) { return (In(appl_summer)/100);
		}else{ return (In(appl_summer));
		};

c_season	-	Correction factor of the standard emission rate depending on season of application. (1 + (Out(appl_summer) * Tech(c_summer) + Out(appl_autumn_winter_spring) * Tech(c_autumn_winter_spring)));

12.5 Detailed process description

This process computes the correction factor for the seasons the solid manure is applied.

12.5.1 References:

Menzi H, Frick R, Kaufmann R 1997. Ammoniak-Emissionen in der Schweiz: Ausmass und technische Beurteilung des Reduktionspotentials. Eidgenössische Forschungsanstalt für Agrarökologie und Landbau, Zürich-Reckenholz. 107pp.

Frick R, Menzi H 1997. Hofdüngeranwendung: Wie Ammoniakverluste vermindern? Auch einfache Massnahmen wirken. FAT Bericht Nr. 496.

13 Livestock

Agrammon Group – 2008-05-07

13.1 Short description

Collects the annual NH3 emission and the N flux for transfer into storage.

13.2 Input parameters

13.3 Technical parameters

13.4 Output

Parameter	Unit	Formula
n_into_storage	kg N /a	Annual N flux (liquid and solid share) from housing and yard into the storage from all animals. Sum(n_from_cattle, Livestock::OtherCattle) + Sum(n_from_dairycow, Livestock::DairyCow) + Sum(n_from_pig, Livestock::Pig) + Sum(n_from_fattening_pig, Livestock::FatteningPigs) + Sum(n_from_equides, Livestock::Equides) + Sum(n_from_other, Livestock::SmallRuminants) + Sum(n_from_poultry, Livestock::Poultry);
nh3_ngrazing	kg N /a	Annual NH3 emission from all grazing areas and Poultry outdoor activities. Sum(nh3_ngrazing, Livestock::OtherCattle::Grazing) + Sum(nh3_ngrazing, Livestock::DairyCow::Grazing) + Sum(nh3_ngrazing, Livestock::Pig::Grazing) + Sum(nh3_ngrazing, Livestock::FatteningPigs::Grazing) + Sum(nh3_ngrazing, Livestock::Equides::Grazing) + Sum(nh3_ngrazing, Livestock::SmallRuminants::Grazing) + Sum(nh3_nfree_range, Livestock::Poultry::Outdoor);
tan_into_storage_poultry-_turkeys_broilers	kg N /a	Annual N flux (poulty manure) as TAN from housing and yard into the storage from poultry. Sum(tan_from_poultry_turkeys_broilers, Livestock::Poultry);
nh3_nyard	kg N /a	Annual NH3 emission from all yards. Sum(nh3_nyard, Livestock::OtherCattle::Yard) + Sum(nh3_nyard, Livestock::Equides::Yard) + Sum(nh3_nyard, Livestock::DairyCow::Yard);
n_into_storage_solid_horses-_otherequides_smallruminants	kg N /a	Annual N flux (solid share) from housing and yard into the storage from all animals besides poultry. Sum(n_solid_from_equides, Livestock::Equides) + Sum(n_solid_from_other, Livestock::SmallRuminants);
nh3_nhousing	kg N /a	Annual NH3 emission from all housings. Sum(nh3_nhousing, Livestock::OtherCattle::Housing) + Sum(nh3_nhousing, Livestock::DairyCow::Housing) + Sum(nh3_nhousing, Livestock::SmallRuminants::Housing) + Sum(nh3_nhousing, Livestock::Pig::Housing) + Sum(nh3_nhousing, Livestock::FatteningPigs::Housing) + Sum(nh3_nhousing, Livestock::Equides::Housing) + Sum(nh3_nhousing, Livestock::Poultry::Housing);
n_remain_pasture	kg N /a	Annual N remaining on pasture from all grazing areas. Sum(n_remain_pasture, Livestock::OtherCattle::Grazing) + Sum(n_remain_pasture, Livestock::DairyCow::Grazing) + Sum(n_remain_pasture, Livestock::Pig::Grazing) + Sum(n_remain_pasture, Livestock::FatteningPigs::Grazing) + Sum(n_remain_pasture, Livestock::Equides::Grazing) + Sum(n_remain_pasture, Livestock::SmallRuminants::Grazing) + Sum(n_remain_free_range, Livestock::Poultry::Outdoor);
n_into_storage_solid-_dairycows_cattle_pigs	kg N /a	Annual N flux (solid share) from housing and yard into the storage from all animals besides poultry. Sum(n_solid_from_cattle, Livestock::OtherCattle) + Sum(n_solid_from_dairycow, Livestock::DairyCow) + Sum(n_solid_from_pig, Livestock::Pig) + Sum(n_solid_from_fattening_pig, Livestock::FatteningPigs);
n_excretion	kg N /a	Total annual N excreted by all animals. Sum(n_excretion, Livestock::OtherCattle) + Sum(n_excretion, Livestock::DairyCow) + Sum(n_excretion, Livestock::Pig) + Sum(n_excretion, Livestock::FatteningPigs) + Sum(n_excretion, Livestock::Equides) + Sum(n_excretion,

13.5 Detailed process description

This process summarizes the annual NH3 emission from livestock (housing, yard and grazing) for all animal categories. Further it calculates the N flux into storage from housing and yard. The manure is splited in solid and liquid/slurry.

14 Livestock::DairyCow

Agrammon Group – 2008-02-29

14.1 Short description

Collects the annual emission of NH3 and the N flux for dairy cows.

14.2 Input parameters

14.3 Technical parameters

14.4 Output

Parameter	Unit	Formula
tan_solid_from_dairycow	kg N /a	Annual N flux as TAN from dairy cows housing and yard, solid fraction. Val('tan_outhousing_solid', DairyCow::Housing) + Val('tan_outyard_solid', DairyCow::Yard);
tan_from_dairycow	kg N /a	Annual N flux as TAN from dairy cow housing and yard. Val(tan_outhousing, DairyCow::Housing) + Val(tan_outyard, DairyCow::Yard);
n_solid_from_dairycow	kg N /a	Annual N flux from dairy cows housing and yard, solid fraction. Val('n_outhousing_solid', DairyCow::Housing) + Val('n_outyard_solid', DairyCow::Yard);
n_from_dairycow	kg N /a	Annual N flux from dairy cows housing and yard. Val('n_outhousing', DairyCow::Housing) + Val('n_outyard', DairyCow::Yard);
nh3_ndairycow	kg N /a	Annual NH3 emission from dairy cows housing, yard and grazing (production). Val('nh3_nhousing', DairyCow::Housing) + Val('nh3_nyard', DairyCow::Yard) + Val('nh3_ngrazing', DairyCow::Grazing);
n_excretion	kg N /a	Annual N excreted by dairy cows. Val('n_excretion', DairyCow::Excretion);
tan_liquid_from_dairycow	kg N /a	Annual N flux as TAN from dairy cow housing and yard, liquid fraction. Val('tan_outhousing_liquid', DairyCow::Housing) + Val('tan_outyard_liquid', DairyCow::Yard);
n_liquid_from_dairycow	kg N /a	Annual N flux from dairy cows housing and yard, liquid fraction. Val('n_outhousing_liquid', DairyCow::Housing) + Val('n_outyard_liquid', DairyCow::Yard);

14.5 Detailed process description

This process summarizes the annual emission of NH3 for dairy cows from housing, yard and grazing. Further it summarizes the annual N flux from the housing to the storage for dairy cows.

15 Livestock::DairyCow::Excretion

Agrammon Group – 2008-03-30

15.1 Short description

Computes the annual N excretion of a number of dairy cows as a function of the milk yield and the feed ration.

15.2 Input parameters

Parameter	Unit	Description
dairy_cows	-	Number of dairy cows in barn.

15.3 Technical parameters

Parameter	Value	Unit	Description
standard_N_excretion	115	kg N /a	Annual standard N excretion for a dairy cow according to Flisch et al. (2009).
share_Nsol	0.60	-	Nsol content of excreta. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
feed_influence_on_Nsol	1	kg Nsol /kg N	Proportion of N (calculated from feed ration correction) excreted as Nsol. Derived from e.g. Peterson et al. (1998).

15.4 Output

Parameter	Unit	Formula
dairy_cows	-	Number of dairy cows in barn. In('dairy_cows');
n_sol_excretion	kg N /a	Annual soluble N excreted by a specified number of animals. Tech(share_Nsol) * Out(n_excretion) + (Out(n_excretion) - Tech(standard_N_excretion)*In('dairy_cows') * Val(cmilk_yield, Excretion::CMilk)) * Tech(feed_influence_on_Nsol);
n_excretion_animal	kg N /a	Annual mean total N excreted per animal. Tech(standard_N_excretion) * Val(cmilk_yield, Excretion::CMilk) * Val(c_feed_ration, Excretion::CFeed);
n_excretion	kg N /a	Annual total N excreted by a specified number of animals. Tech(standard_N_excretion) * Val(cmilk_yield, Excretion::CMilk) * Val(c_feed_ration, Excretion::CFeed) * In('dairy_cows');

15.5 Detailed process description

This process calculates the annual N excretion (total N and Nsol (urea plus measured total ammoniacal nitrogen)) of a number of dairy cows as a function of the milk yield and the supplied feed ration. Nitrogen surpluses from increased nitrogen uptake are primarily excreted as Nsol in the urine. Eighty percent of the increased N excretion is therefore added to the Nsol fraction.

The standard N excretion was taken from the official Swiss fertilizer guidelines. These values were compiled on the basis of official feeding recommendations (RAP 1999) by a group of feeding experts under the lead of H. Menzi. Even though the methodology used is not documented in detail, it was well known to the authors of DYNAMO.

15.5.1 References:

Burgos SA, Robinson PH, Fadel JG, DePeters EJ 2005. Ammonia volatilization potential: Prediction of urinary urea nitrogen output on lactating dairy cows. Agriculture, Ecosystems and Environment 111:261-269.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

RAP 1999. Fütterungsempfehlungen und Nährwerttabelle für Wiederkäuer. 4. überarbeitete Auflage, 327p, Landwirtschaftliche Lehrmittelzentrale, Zollikofen.

Flisch R, Sinaj S, Charles R, Richner W 2009. Grundlagen für die die Düngung im Acker- und Futterbau. Agrarforschung 16(2).

16 Livestock::DairyCow::Excretion::CConcentrates

Agrammon Group – 2007-07-12

16.1 Short description

Computes the correction factor for the annual N excretion of a dairy cow as a function of the amount and type of concentrates used.

16.2 Input parameters

Parameter	Unit	Description
amount_summer	kg /d	Amount of concentrates in summer per animal per day.
amount_winter	kg /d	Amount of concentrates in winter per animal per day.

16.3 Technical parameters

Parameter	Value	Unit	Description
par_a_summer	0.04	d /kg	Parameter a of linear regression a + b*x.
par_b_summer	-0.04	-	Parameter a of linear regression a + b*x.
par_a_winter	0.01	d /kg	Parameter a of linear regression a + b*x.
par_b_winter	-0.005	-	Parameter b of linear regression a + b*x.

16.4 Output

Parameter	Unit	Formula
c_concentrates_summer	-	Calculation of correction to exretions with 0.3, 0.5, 1, 2, 3, 4, 6 kg of concentrate (barley and wheat) per cow per day, taking into account the amount of roghage substituted by the concentrate (according to the energy content) and the relative differnce of the protein content of the roughage and the concentrate. Results used to calculate a regression for % modification of N excretion due to concentrate quantity summer. Standard for Summer = 1 kg animal-1 day-1. Tech(par_a_summer) + Tech(par_b_summer) * In('amount_summer');
c_concentrates_winter	-	Calculation of correction to exretions with 0.3, 0.5, 1, 2, 3, 4, 6 kg of concentrate (barley and wheat) per cow per day, taking into account the amount of roghage substituted by the concentrate (according to the energy content) and the relative differnce of the protein content of the roughage and the concentrate. Results used to calculate a regression for % modification of N excretion due to concentrate quantity summer. Standard for Winter = 2 kg animal-1 day-1. Tech(par_a_winter) + Tech(par_b_winter) * In('amount_winter');

16.5 Detailed process description

This formula takes into account the amount of concentrates used per cow during the winter and summer feeding period. The correction is based on the fact that concentrates (grains) can specifically balance the energy to protein ratio, thus reducing the crude protein.

16.5.1 References:

Flückiger E 1989. Stickstoff- und Mineralstoffumsatz von Milchkühen in Abhängigkeit von Rationentyp und Produktionsphase unter besonderer Berücksichtigung umweltrelevanter Aspekte. Diss ETH Nr 8865.

17 Livestock::DairyCow::Excretion::CFeed

Agrammon Group – 2008-02-19

17.1 Short description

Computes the correction factor for the annual N excretion of a dairy cow as a function of the summer and winter feed ration, and the amount and type of concentrates used.

17.2 Input parameters

17.3 Technical parameters

Parameter	Value	Unit	Description
d_summer	0.55	-	Duration of summer feeding period (200 days). Average for different altitude zones.
d_winter	0.45	-	Duration of the winter feeding period (165 days). Average for different altitude zones.

17.4 Output

Parameter	Unit	Formula
c_feed_ration	-	Feed ration correction factor for annual N excretion. 1 + (Tech(d_summer) * Val(c_summer_ration, CFeedSummerRatio) + Tech(d_winter) * Val(c_winter_ration, CFeedWinterRatio) + Tech(d_summer) * Val(c_concentrates_summer, CConcentrates) + Tech(d_winter) * Val(c_concentrates_winter, CConcentrates));

17.5 Detailed process description

This process accounts for the fact, that special rations can result in higher or lower N excretions as compared to standard excretions from Flisch et al. (2009). A differentiated consideration of the duration of the summer and winter feeding period according to farm location (altitude etc.) is possible but was not implemented for the emission inventory.

17.5.1 References:

Flisch R, Sinaj S, Charles R, Richner W 2009. Grundlagen für die die Düngung im Acker- und Futterbau. Agrarforschung 16(2).

18 Livestock::DairyCow::Excretion::CFeedSummerRatio

Agrammon Group – 2008-02-19

18.1 Short description

Computes the correction factor for the annual N excretion of a dairy cow as a function of the summer feed ration.

18.2 Input parameters

Parameter	Unit	Description
share_hay_summer	%	Proportion of animals receiving hay in summer.
share_maize_silage_summer	%	Proportion of animals receiving maize silage in summer.
share_maize_pellets_summer	%	Proportion of animals receiving maize pellets in summer.

18.3 Technical parameters

Parameter	Value	Unit	Description
c_hay_summer	-0.05	-	Modification of annual N excretion by adding hay to the standard ration during the summer feeding period.
c_maize_silage_summer	-0.08	-	Modification of annual N excretion by adding maize silage to the standard ration during summer feeding period.
c_maize_pellets_summer	-0.04	-	Modification of annual N excretion by adding maize pellets to the standard ration during summer feeding period.

18.4 Output

Parameter	Unit	Formula
c_summer_ration	-	Summer feed ration correction factor for annual N excretion. Tech(c_hay_summer) * Out('share_hay_summer') + Tech(c_maize_silage_summer) * Out('share_maize_silage_summer') + Tech(c_maize_pellets_summer) * Out('share_maize_pellets_summer');

share_hay_summer	-	Share
		
		if (In('share_hay_summer') > 1) { return (In('share_hay_summer')/100);
		} else { return (In('share_hay_summer'));
		};

share_maize_silage_summer	-	Share
		
		if (In('share_maize_silage_summer') > 1) { return (In('share_maize_silage_summer')/100);
		} else { return (In('share_maize_silage_summer'));
		};

share_maize_pellets_summer	-	Share
		
		if (In('share_maize_pellets_summer') > 1) { return (In('share_maize_pellets_summer')/100);
		} else { return (In('share_maize_pellets_summer'));
		};

18.5 Detailed process description

This process calculates the correction factor for N excretion during the summer feeding period as compared to the standard excretion values of Walther et al. (2001). The average feed ration considered for the standard excretion presented in Walther et al. (2001) was calculated as average of four summer and four winter standard rations using dsummer and dwinter mentioned above. To calculate the N excretion of farm-specific summer rations, excretions were calculated with the same model used by the authors of Walther et al. (2001) (based on official feeing recommendations (RAP 1999)) using proportions of the specific feed typically used on farms (expert assumptions). No correction was considered for grass and grass silage, because grass is used by virtually all farms during the summer feeding period und because the crude protein content of grass silage is not much lower than that of grass. The thus calculated summer excretions were then expressed as

18.5.1 References:

RAP 1999. Fütterungsempfehlungen und Nährwerttabellen für Wiederkäuer. 4. überarbeitete Auflage. LMZ Zollikofen. Walther U, Ryser JP, Flisch R (Eds.) 2001. Grundlagen für die Düngung im Acker- und Futterbau 2001. Agrarforschung 8:1-80.

19 Livestock::DairyCow::Excretion::CFeedWinterRatio

Agrammon Group – 2008-05-02

19.1 Short description

Computes the correction factor for the annual N excretion of a dairy cow as a function of the winter feed ration.

19.2 Input parameters

Parameter	Unit	Description
share_maize_silage_winter	%	Proportion of animals receiving maize silage in winter.
share_grass_silage_winter	%	Proportion of animals receiving grass silage in winter.
share_maize_pellets_winter	%	Proportion of animals receiving maize pellets in winter.
share_potatoes_winter	%	Proportion of animals receiving potatoes in winter.
share_beets_winter	%	Proportion of animals receiving beets in winter.

19.3 Technical parameters

Parameter	Value	Unit	Description
c_grass_silage_winter	0.027	-	Modification of annual N excretion by adding grass silage to the standard ration during winter feeding period.
c_maize_silage_winter	-0.016	-	Modification of annual N excretion by adding maize silage to the standard ration during winter feeding period.
c_maize_pellets_winter	-0.014	-	Modification of annual N excretion by adding maize pellets to the standard ration during winter feeding period.
c_potatoes_winter	0.01	-	Modification of annual N excretion by adding potatoes to the standard ration during the winter feeding period.
c_beets_winter	0.019	-	Modification of annual N excretion by adding beets to the standard ration during the winter feeding period.

19.4 Output

Parameter	Unit	Formula

share_maize_pellets_winter	-	Share
		
		if (In('share_maize_pellets_winter') > 1) { return (In('share_maize_pellets_winter')/100);
		} else { return (In('share_maize_pellets_winter'));
		};

share_potatoes_winter	-	Share
		
		if (In('share_potatoes_winter') > 1) { return (In('share_potatoes_winter')/100);
		} else { return (In('share_potatoes_winter'));
		};

share_beets_winter	-	Share
		
		if (In('share_beets_winter') > 1) { return (In('share_beets_winter')/100);
		} else { return (In('share_beets_winter'));
		};

c_winter_ration	-	Winter feed ration correction factor for annual N excretion. Tech(c_grass_silage_winter) * Out('share_grass_silage_winter') + Tech(c_maize_silage_winter) * Out('share_maize_silage_winter') + Tech(c_maize_pellets_winter) * Out('share_maize_pellets_winter') + Tech(c_potatoes_winter) * Out('share_potatoes_winter') + Tech(c_beets_winter) * Out('share_beets_winter');

share_maize_silage_winter	-	Share
		
		if (In('share_maize_silage_winter') > 1) { return (In('share_maize_silage_winter')/100);
		} else { return (In('share_maize_silage_winter'));
		};

share_grass_silage_winter	-	Share
		
		if (In('share_grass_silage_winter') > 1) { return (In('share_grass_silage_winter')/100);
		} else { return (In('share_grass_silage_winter'));
		};

19.5 Detailed process description

This process calculates the correction factor for the N excretion during the winter feeding period as compared to the standard excretion values of Walther et al. (2001). The average feed ration considered for the standard excretion presented in Walther et al. (2001) was calculated as average of four summer and four winter standard rations using dsummer and dwinter mentioned above. To calculate the N excretion of farm-specific winter rations, excretions were calculated with the same model used by the authors of Walther et al. (2001) (based on official feeding recommendations (RAP 1999)) using proportions of the specific feed typically used on farms (expert assumptions). No correction was considered for hay, because hay is used by virtually all farms during the winter feeding period. The thus calculated winter excretions were then expressed as

19.5.1 References:

RAP 1999. Fütterungsempfehlungen und Nährwerttabellen für Wiederkäuer. 4. überarbeitete Auflage. LMZ Zollikofen. Walther U,Ryser JP, Flisch R (Eds.) 2001. Grundlagen für die Düngung im Acker- und Futterbau 2001. Agrarforschung 8:1-80.

20 Livestock::DairyCow::Excretion::CMilk

Agrammon Group – 2008-02-29

20.1 Short description

Computes the correction factor for the annual N excretion of a dairy cow as a function of the milk yield.

20.2 Input parameters

Parameter	Unit	Description
milk_yield	kg /a	Annual milk yield per dairy cow.

20.3 Technical parameters

Parameter	Value	Unit	Description
standard_milk_yield	6500	kg /a	Annual standard milk yield per dairy cow.
a_high	0.02	-	For milk yield > 6500
a_low	0.1	-	For milk yield < 6500

20.4 Output

Parameter	Unit	Formula

cmilk_yield	-	Milk yield correction factor for annual N excretion.
		
		my $a;
		if (In('milk_yield') > Tech(standard_milk_yield)) { $a = Tech(a_high);
		} else { $a = Tech(a_low);
		}
		return (1 + ((In('milk_yield') - Tech(standard_milk_yield))/1000) * $a);

20.5 Detailed process description

This process describes the relationship between the milk yield and the N excretion. While the N excretion decreases by 10

20.5.1 References:

Flisch R, Sinaj S, Charles R, Richner W (Eds.) 2009. Grundlagen für die die Düngung im Acker- und Futterbau 2009 (GRUDAF), Agrarforschung 16.2.

21 Livestock::DairyCow::Grazing

Agrammon Group – 2008-04-23

21.1 Short description

Computes the annual NH3 emission from grazing dairy cows.

21.2 Input parameters

Parameter	Unit	Description
grazing_days	d /a	Average grazing days per year.
grazing_hours	h /d	Average grazing hours per day.

21.3 Technical parameters

Parameter	Value	Unit	Description
er_dairycow_grazing	0.05	-	Emission rate for the calculation of the annual NH3 emission during grazing for dairy cows. 5% Ntot (conversion with a portion of Nsol of 60%: EF 8.3% TAN; value based on Table 1 (Mean emission rate of 3.1% N excreted; range: 1.6-5.7% for grazing cows on a sward fertilized with 250 kg N/y) of Bussink (1992) and Table 3 (Mean emission rate of 3.3% N excreted; range: 0.0-7.4% for grazing cows on a sward fertilized with 250 kg N/y) of Bussink (1994)). The corresponding value is rather lower for Switzerland since the level of fertilization is lower resulting in a lower level for crude protein. The N level in the fodder of the sward fertilized with 250 kg N/y (31 g/kg d.m.; Table 4) is comparable to values common for Switzerland (Bussink (1994)). The EF chosen includes a safety margin.

21.4 Output

Parameter	Unit	Formula
grazing_days	d /a	Grazing days per year. In(grazing_days);
nh3_ngrazing	kg N /a	Annual total NH3 emission from all grazing dairy cows. Out(n_into_grazing) * Tech(er_dairycow_grazing);
n_into_grazing	kg N /a	Annual total N excretion during grazing for dairy cows. Val(n_excretion, Excretion) * In(grazing_days) / 365 * In(grazing_hours) / 24;
n_remain_pasture	kg N /a	Annual N input on pasture. Out(n_into_grazing) - Out(nh3_ngrazing);

nh3_ngrazing_animal	kg N /a	Annual NH3 emission per dairy cow from grazing.
		
		if(Val(dairy_cows, Excretion) != 0){ return Out(nh3_ngrazing) / Val(dairy_cows, Excretion);
		} else { return 0;
		};

n_sol_into_grazing	kg N /a	Annual soluble N (TAN) excretion during grazing for dairy cows. Val(n_sol_excretion, Excretion) * In(grazing_days) / 365 * In(grazing_hours) / 24;
grazing_hours	h /d	Grazing hours per day. In(grazing_hours);

21.5 Detailed process description

This process calculates the annual NH3 emission from grazing dairy cows based on the total N excreted on the pastures. The N excreted is calculated according to the time the animals spend on the pasture. It assumes that the excretions on the pasture are proportional to the time the animals are grazed.

21.5.1 References:

Bussink DW 1992. Ammonia volatilization from grassland receiving nitrogen fertilizer and rotationally grazed by dairy cattle. Fertilizer Research 33:257-265.

Bussink DW 1994. Relationship between ammonia volatilization and nitrogen fertilizer application rate, intake and excretion of herbage nitrogen by cattle on grazed swards. Fertilizer Research 38:111-121.

Jarvis SC, Hatch DJ, Lockyer DR 1989. Ammonia fluxes from grazed grassland: annual losses from cattle production systems and their relation to nitrogen inputs. Journal of Agricultural Science 113:99-108.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

Ross CA, Jarvis SC 2001. Measurement of emission and deposition pattern of ammonia from urine in grass swards. Atmospheric environment 35:867-875.

22 Livestock::DairyCow::Housing

Agrammon Group – 2008-04-22

22.1 Short description

Computes the annual NH3 emission from dairy cow housing systems.

22.2 Input parameters

22.3 Technical parameters

22.4 Output

Parameter	Unit	Formula
tan_outhousing_liquid	kg N /a	Annual N flux as TAN out of housing, slurry or liquid fraction of manure from dairy cows. Out(n_outhousing) * Val(share_liquid, Housing::Type) * Out(share_tan_out);
n_outhousing_liquid	kg N /a	Annual N flux out of housing, slurry or liquid fraction of manure from dairy cows. Out(n_outhousing) * Val(share_liquid, Housing::Type);
n_outhousing	kg N /a	Annual N flux out of the housing. Out(n_into_housing) - Out(nh3_nhousing);
n_into_housing	kg N /a	Annual N flux into the house. Val(n_excretion, Excretion) - Val(n_into_grazing, Grazing) - Val(n_into_yard, Yard);
tan_outhousing	kg N /a	Annual N flux as TAN out of the housing. Out(n_sol_into_housing) - Out(nh3_nhousing);
nh3_nhousing	kg N /a	Annual NH3 emission from dairy cow housing systems per animal place. (Val(n_sol_excretion, Excretion) - Val(n_sol_reduction_house, Yard)) * Val(k_grazing, Housing::KGrazing) * Val(er_housing, Housing::Type) * Val(k_area, Housing::Type) * Val('c_UNECE', Housing::Floor);
n_sol_into_housing	kg N /a	Annual N flux as TAN into the house. Val(n_sol_excretion, Excretion) - Val(n_sol_into_grazing, Grazing) - Val(n_sol_into_yard, Yard);
tan_outhousing_solid	kg N /a	Annual N flux as TAN out of housing from solid fraction of manure. Out(n_outhousing) * (1 - Val(share_liquid, Housing::Type)) * Out(share_tan_out);
n_outhousing_solid	kg N /a	Annual N flux out of housing from solid fraction of manure. Out(n_outhousing) * (1 - Val(share_liquid, Housing::Type));
share_tan_out	-	Share of TAN for interface to storage, the same share is assumed for solid and liquid parts of output. Mineralization and immobilization are considerd in the storage module. if(Out(n_outhousing) != 0){ Out(tan_outhousing) / Out(n_outhousing) }else{0};

22.5 Detailed process description

This process calculates the NH3 emission in dairy cow housing depending on the N excretion and the housing systems. The NH3 emission is assumed to be proportional to the total N excretion of the animals because the contaminated surfaces will primarily drive emission, which will remain active even when animals are on the pasture or exercise yard.

A proportional correction is applied according to the area per animal.
A correction is applied if the part of the day grazing is above a defined grazing hours per days.

22.5.1 Definition of System boundaries for the housing Process:

For housing systems with integrated exercise yards, it is difficult to distinguish between emissions from housing, exercise yard and storage. For these housingtypes the emission may be only validated for the sum of housing, exercise yard and storage emission.

23 Livestock::DairyCow::Housing::Floor

Agrammon Group – 2008-03-30

23.1 Short description

Computes the annual NH3 reduction due to a grooved floor in housing systems.

23.2 Input parameters

Parameter	Unit	Description
UNECE_category_1-_mitigation_options_for-_housing_systems_for_dairy-_cows	-	UNECE category 1 mitigation options for housing systems for other cattle(none, toothed scrapper running over a grooved floor). Possible values: `toothed_scrapper_running_over_a_grooved_floor`, `none`

23.3 Technical parameters

Parameter	Value	Unit	Description
red_UNECE	0.25	-	Reduction efficiency as compared to cubicle house (UNECE 2007, paragraph 57, table 4).

23.4 Output

Parameter	Unit	Formula

c_UNECE	-	Reduction factor for the emission due to the use of a grooved floor in housing systems.
		if (In('UNECE_category_1_mitigation_options_for_housing_systems_for_dairy_cows eq 'toothed_scrapper_running_over_a_grooved_floor'){ return (1 - Tech('red_UNECE'));
		} else { return 1;
		};

23.5 Detailed process description

This submodul calculates the annual NH3 reduction due to a grooved floor in housing systems according to the UNECE guideline 2007.

23.5.1 References

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. ECE/EB.AIR/WG.5/2007/13.

24 Livestock::DairyCow::Housing::KGrazing

Agrammon Group – 2008-04-1

24.1 Short description

Computes the correction factor for the reduction of the housing emission if the number of grazing hours per day does increase a specific limit.

24.2 Input parameters

24.3 Technical parameters

Parameter	Value	Unit	Description
k_grazing_reduction_lw5h	0	-	Reduction of housing emissions to 0% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw12h	0.2	-	Reduction of housing emissions to 20% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw22h	0.5	-	Reduction of housing emissions to 50% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_gt22h	1.0	-	Reduction of housing emissions to 100% due to extensive grazing/alping and milking using a mobile milking parlor. Empirical estimation.

24.4 Output

Parameter	Unit	Formula
k_grazing	-	The correction factor for the reduction of the housing emission depending on the number of grazing hours per day and the grazing days per year. if (Val('grazing_hours', '..::Grazing') < 5){ return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_lw5h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } elsif (Val('grazing_hours', '..::Grazing') < 12.0){ return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_lw12h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } elsif (Val('grazing_hours', '..::Grazing') < 22.0) { return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_lw22h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } elsif (Val('grazing_hours', '..::Grazing') >= 22.0) { return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_gt22h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } else { return 1; # no correction };

24.5 Detailed process description

This process calculates the correction factor for the non proportional change of the housing emission according to the grazing hours per day (Webb et al. 2005). It is based on an empirical estimation of Menzi and Katz (1997). The concept has been lately supported by measurements in the UK (Defra 2005), where reductions comparable to those assumed by Menzi and Katz (1997) were reported.

24.5.1 References:

Department for Environment, Food & Rural Affairs, Defra 2002. Ammonia in the UK. DEFRA Publications, London. Menzi H, Katz PE 1997. A differentiated approach to calculate ammonia emissions from animal husbandry. In: Voermans JAM and Monteny GJ (Eds): "Ammonia and odour emissions from animal production facilities", Proc. International Symposium, Vinkeloord, NL, 6-10 October 1997, 35-42.

Webb J, Misselbrook TH 2005. A mass-flow model of ammonia emissions from UK livestock production. Atmospheric environment 38: 2163-2176.

25 Livestock::DairyCow::Housing::Type

Agrammon Group – 2008-02-19

25.1 Short description

Selects the emission rate and other correction factors for the specific housing types for dairy cows.

25.2 Input parameters

Parameter	Unit	Description
housing_type	-	Type of housing. Possible values: `Loose_Housing_Deep_Litter`, `Loose_Housing_Slurry`, `Loose_Housing_Slurry_Plus_Solid_Manure`, `Tied_Housing_Slurry_Plus_Solid_Manure`, `Tied_Housing_Slurry`
dimensioning_barn	-	Number of available animal places.

25.3 Technical parameters

25.4 Output

Parameter	Unit	Formula
housing_type	-	Housing type (needed in other modules). In('housing_type');

area_increase	-	Factor on what barn size does increase the regularized minimal, limited to 0.5.
		
		if((Val(dairy_cows, '..::Excretion') < In('dimensioning_barn')) and (Val(dairy_cows, '..::Excretion') != 0)){ if(In('dimensioning_barn') >= (Val(dairy_cows, '..::Excretion') * 1.5)){ return 0.5;
		} else { if(Val('dairy_cows', '..::Excretion') > 0){ return((In('dimensioning_barn') / Val(dairy_cows, '..::Excretion')) -1);
		}else { return 0;
		}
		}
		} else { return 0.0;
		};

share_liquid	-	Liquid share for the housing type. Val(share_liquid, 'Type::' . In('housing_type'));
er_housing	-	Emission rate for the housing type. Val('er_housing', 'Type::' . In('housing_type'));
k_area_type	-	Correction factor for the housing type area. Val(k_area, 'Type::' . In('housing_type'));
share_solid	-	Solid share for the housing type. Val(share_solid, 'Type::' . In('housing_type'));
k_area	-	Correction factor for area per animal. 1 + (Out(area_increase) * Out(k_area_type));

25.5 Detailed process description

This process selects the correction factor for the specific housing types for dairy cows. Among these correction factors are the emission rate for the housing type, the correction factor for the housing type area, the correction factor for the area per animal, the liquid and solid share for the housing type as well as the factor on what barn size increases the regularized minimal (limited to 0.5).

26 Livestock::DairyCow::Housing::Type::Loose_Housing_Deep_Litter

Agrammon Group – 2008-04-18

26.1 Short description

Describes correction factors for the loose housing deep litter system for dairy cows.

26.2 Input parameters

26.3 Technical parameters

Parameter	Value	Unit	Description
er	0.183	-	Emission rate for the loose housing deep litter system for dairy cows. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 11% Ntot; convered using Nsol of 60%: EF 18.3% TAN. Reference value UNECE(2007): 11 kg NH3 = 8% TAN.
share_liquid	0	-	For the loose housing deep litter system 100% of the manure goes into the solid manure storage/application.
k_area	0.5	-	According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: it is assumed that additional surfaces are entirely used since barriers are hardly fea-sible. The emission is increased by 5% per 10% of additional surfaces up to a maximum of 50% additional surface.

26.4 Output

Parameter	Unit	Formula
share_liquid	-	Part of Ntot flowing into liquid storage for selected housing type. `Tech(share_liquid);`
er_housing	-	Emission rate for specific housing type. `Tech(er);`
share_solid	-	Share of solid manure of Ntot for selected housing type. `1-Tech(share_liquid);`
k_area	-	Correction factor for area per animal. `Tech(k_area);`

26.5 Detailed process description

This process describes the correction factors for the loose housing deep litter system for dairy cows such as the housing specific emission rate, the area per animal correction, the liquid share and solid share.

26.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. UNECE executive body for the convention on long-range transboundary air pollution, Working Group on Strategies and Review, EB.AIR/WH.5/2007/13/ 16 July 2007, Genf. 35p.

27 Livestock::DairyCow::Housing::Type::Loose_Housing_Slurry

Agrammon Group – 2008-04-18

27.1 Short description

Describes correction factors for the loose housing slurry system for dairy cows.

27.2 Input parameters

27.3 Technical parameters

Parameter	Value	Unit	Description
er	0.183	-	Emission rate for the loose housing slurry system for dairy cows. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 11% Ntot; converted using Nsol of 60%: EF 18.3% TAN. Reference value UNECE(2007): 11 kg HN3 = 8% TAN.
share_liquid	1	-	For the loose housing slurry system 100% of the manure goes into the liquid fraction of the storage/application.
k_area	0.5	-	According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: it is assumed that additional surfaces are entirely used since barriers are hardly fea-sible. The emission is increased by 5% per 10% of additional surfaces up to a maximum of 50% additional surface.

27.4 Output

Parameter	Unit	Formula
share_liquid	-	Part of Ntot flowing into liquid storage for selected housing type. `Tech(share_liquid);`
er_housing	-	Emission rate for specific housing type. `Tech(er);`
share_solid	-	Share of solid manure of Ntot for selected housing type. `1-Tech(share_liquid);`
k_area	-	Correction factor for area per animal. `Tech(k_area);`

27.5 Detailed process description

This process describes the correction factors for the loose housing slurry system for dairy cows such as the housing specific emission rate, the area per animal correction, the liquid share and solid share.

27.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. UNECE executive body for the convention on long-range transboundary air pollution, Working Group on Strategies and Review, EB.AIR/WH.5/2007/13/ 16 July 2007, Genf. 35p.

28 Livestock::DairyCow::Housing::Type::Loose_Housing_Slurry-_Plus_Solid_Manure

Agrammon Group – 2008-04-18

28.1 Short description

Describes correction factors for the loose housing liquid solid system for dairy cows.

28.2 Input parameters

28.3 Technical parameters

Parameter	Value	Unit	Description
er	0.183	-	Emission rate for the loose housing liquid solid system for dairy cows. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 11% Ntot; converted using Nsol of 60%: EF 18.3% TAN. Reference value UNECE(2007): 11 kg NH3 = 8% TAN.
share_liquid	0.57	-	For the loose housing liquid-solid system 57% of the N of the manure goes into the liquid manure storage.
k_area	0.5	-	According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: it is assumed that additional surfaces are entirely used since barriers are hardly fea-sible. The emission is increased by 5% per 10% of additional surfaces up to a maximum of 50% additional surface.

28.4 Output

Parameter	Unit	Formula
share_liquid	-	Part of Ntot flowing into liquid storage for selected housing type. `Tech(share_liquid);`
er_housing	-	Emission rate for specific housing type. `Tech(er);`
share_solid	-	Share of solid manure of Ntot for selected housing type. `1-Tech(share_liquid);`
k_area	-	Correction factor for area per animal. `Tech(k_area);`

28.5 Detailed process description

This process describes the correction factors for the loose housing liquid solid system for dairy cows such as the housing specific emission rate, the area per animal correction, the liquid share and solid share.

28.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. UNECE executive body for the convention on long-range transboundary air pollution, Working Group on Strategies and Review, EB.AIR/WH.5/2007/13/ 16 July 2007, Genf. 35p.

29 Livestock::DairyCow::Housing::Type::Tied_Housing_Slurry

Agrammon Group – 2008-04-18

29.1 Short description

Describes correction factors for the tied housing slurry system for daiy cows.

29.2 Input parameters

29.3 Technical parameters

Parameter	Value	Unit	Description
er	0.067	-	Emission rate for the tied housing slurry system for dairy cows. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 4% Ntot; converted using Nsol of 60%: EF 6.7% TAN.
share_liquid	1	-	For the tied housing slurry system 100% of the manure goes into the liquid fraction of the storage/application.
k_area	0	-	Additional surfaces are not used.

29.4 Output

Parameter	Unit	Formula
share_liquid	-	Part of Ntot flowing into liquid storage for selected housing type. `Tech(share_liquid);`
er_housing	-	Emission rate for specific housing type. `Tech(er);`
share_solid	-	Share of solid manure of Ntot for selected housing type. `1-Tech(share_liquid);`
k_area	-	Correction factor for area per animal. `Tech(k_area);`

29.5 Detailed process description

This process describes the correction factors for the tied housing slurry system for dairy cows such as the housing specific emission rate, the area per animal correction, the liquid share and solid share.

30 Livestock::DairyCow::Housing::Type::Tied_Housing_Slurry_Plus-_Solid_Manure

Agrammon Group – 2008-04-18

30.1 Short description

Describes correction factors for the tied housing liquid solid system for dairy cows.

30.2 Input parameters

30.3 Technical parameters

Parameter	Value	Unit	Description
er	0.067	-	Emission rate for the tied housing liquid solid system for dairy cows. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 4% Ntot, converted using Nsol of 60%: EF 6.7% TAN.
share_liquid	0.57	-	For the tied housing liquid solid system 57% of the manure goes into the liquid fraction of the storage/application.
k_area	0	-	Additional surfaces are not used.

30.4 Output

Parameter	Unit	Formula
share_liquid	-	Part of Ntot flowing into liquid storage for selected housing type. Tech(share_liquid);
er_housing	-	Emission rate for specific housing type. Tech(er);
share_solid	-	Share of solid manure of Ntot for selected housing type. 1-Tech(share_liquid);
k_area	-	Correction factor for area per animal. Tech(k_area);

30.5 Detailed process description

This process describes the correction factors for the tied housing liquid solid system for dairy cows such as the housing specific emission rate, the area per animal correction, the liquid share and solid share.

31 Livestock::DairyCow::Yard

Agrammon Group – 2008-03-30

31.1 Short description

Computes the annual NH3 emission from dairy cow on exercise yards based on the access time and if the the basic feeding is on the yard.

31.2 Input parameters

Parameter	Unit	Description
yard_days	d /a	Access to exercise yard in days per year.
exercise_yard	-	Exercise yard: not available, available: roughage is not supplied in the exercise yard, available: roughage is partly supplied in the exercise yard, available: roughage is exclusively supplied in the exercise yard. Possible values: `available_roughage_is_exclusively_supplied_in_the_exercise_yard`, `available_roughage_is_not_supplied_in_the_exercise_yard`, `available_roughage_is_partly_supplied_in_the_exercise_yard`, `not_available`
floor_properties_exercise_yard	-	Floor properties(solid floor, unpaved floor, perforated floor, paddock or pasture used as exercise yard). Possible values: `paddock_or_pasture_used_as_exercise_yard`, `perforated_floor`, `unpaved_floor`, `solid_floor`

31.3 Technical parameters

Parameter	Value	Unit	Description
er_yard	0.7	-	Emission rate for TAN on yard.
share_available_roughage_is-_exclusively_supplied_in_the-_exercise_yard	0.6	-	Share of excretion per day for animals with roughage exclusively on the yard.
share_available_roughage_is-_partly_supplied_in_the-_exercise_yard	0.2	-	Share of excretion per day for animals with roughage partly on the yard.
share_available_roughage-_is_not_supplied_in_the-_exercise_yard	0.1	-	Share of excretion per day for animals with roughage not supplied in the yard.
red_floor_properties_solid-_floor	0.0	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties_unpaved-_floor	0.5	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties-_perforated_floor	0.8	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties_paddock-_or_pasture_used_as-_exercise_yard	0.9	-	Reduction efficiency according to Reidy and Menzi.

31.4 Output

Parameter	Unit	Formula
n_into_yard	kg N /a	Annual N excretion on yard for a defined animal category. Val(n_excretion, Excretion) * (In('yard_days') / 365) * Out(share_excretion_yard);
tan_outyard_solid	kg N /a	Annual N flux as TAN from solid part out of yard into storage. 0;

nh3_nyard_animal	kg N /a	Annual NH3 emission per anmimal from yard.
		
		if(Val(dairy_cows, Excretion) != 0){ return Out(nh3_nyard) / Val(dairy_cows, Excretion);
		} else { return 0;
		};

share_excretion_yard	-	Share of excretion on the yard according the stay on yard. If the basic feeding is on the yard the share_basicfeeding is assumed. Otherwise the share is selected according to the access.
		
		if(In('exercise_yard') eq 'available_roughage_is_not_supplied_in_the_exercise_yard') { return Tech('share_available_roughage_is_not_supplied_in_the_exercise_yard');
		} elsif(In('exercise_yard') eq 'available_roughage_is_partly_supplied_in_the_exercise_yard') {
		return Tech('share_available_roughage_is_partly_supplied_in_the_exercise_yard'
		} elsif(In('exercise_yard') eq 'available_roughage_is_exclusively_supplied_in_the_exercise_yard')
		{ return Tech('share_available_roughage_is_exclusively_supplied_in_the_exercise_
		} elsif(In('exercise_yard') eq 'not_available') { return 0;
		};

nh3_nyard	kg N /a	Annual NH3 emission from yard. Out(n_sol_into_yard) * Tech(er_yard) * (1 - (Out(c_floor_properties_exercise_yard)));

n_sol_reduction_house	-	Reduction of excerteion in housing according to extensive use of the Yard, when the basic feeding is on the yard.
		
		if(In('exercise_yard') eq 'available_roughage_is_exclusively_supplied_in_the_exercise_yard') { return (Val(n_sol_excretion, Excretion) * (In('yard_days') / 365) * Out(share_excretion_yard) * 0.5);
		} else { return 0.0;
		}

n_outyard	kg N /a	Annual N flux out of yard. Out(n_into_yard) - Out(nh3_nyard);
n_sol_into_yard	kg N /a	Annual soluble N excretion on yard for a defined animal category. Val(n_sol_excretion, Excretion) * (In('yard_days') / 365) * Out(share_excretion_yard);
n_outyard_liquid	kg N /a	Annual N flux from liquid part out of yard. Out(n_into_yard) - Out(nh3_nyard);
n_outyard_solid	kg N /a	Annual N flux from solid part out of yard. 0;
tan_outyard_liquid	kg N /a	Annual N flux as TAN from liquid part out of yard into storage. Out(n_sol_into_yard) - Out(nh3_nyard);
tan_outyard	kg N /a	Annual N flux as TAN out of yard into storage. Out(n_sol_into_yard) - Out(nh3_nyard);

31.5 Detailed process description

32 Livestock::Equides

Agrammon Group – 2008-02-29

32.1 Short description

Collects the annual emission of NH3 and the N flux for equides.

32.2 Input parameters

32.3 Technical parameters

32.4 Output

Parameter	Unit	Formula
n_solid_from_equides	kg N /a	Annual N flux from equides housing and yard, solid fraction. Val('n_outhousing_solid', Equides::Housing) + Val('n_outyard_solid', Equides::Yard);
n_liquid_from_equides	kg N /a	Annual N flux from equides housing and yard, liquid fraction. Val('n_outhousing_liquid', Equides::Housing) + Val('n_outyard_liquid', Equides::Yard);
tan_from_equides	kg N /a	Annual N flux as TAN from dairy cow housing and yard. Val(tan_outhousing, Equides::Housing) + Val(tan_outyard, Equides::Yard);
tan_solid_from_equides	kg N /a	Annual N flux as TAN from equides housing and yard, solid fraction. Val('tan_outhousing_solid', Equides::Housing) + Val('tan_outyard_solid', Equides::Yard);
tan_liquid_from_equides	kg N /a	Annual N flux as TAN from dairy cow housing and yard, liquid fraction. Val('tan_outhousing_liquid', Equides::Housing) + Val('tan_outyard_liquid', Equides::Yard);
n_excretion	kg N /a	Annual N excreted by equides. Val('n_excretion', Equides::Excretion);
n_from_equides	kg N /a	Annual N flux from equides housing and yard. Val('n_outhousing', Equides::Housing) + Val('n_outyard', Equides::Yard);
nh3_nequides	kg N /a	Annual NH3 emission from equides housing, yard and grazing (production). Val('nh3_nhousing', Equides::Housing) + Val('nh3_nyard', Equides::Yard) + Val('nh3_ngrazing', Equides::Grazing);

32.5 Detailed process description

This process summarizes the annual emission of NH3 for equides from housing, yard and grazing. Further it summarizes the annual N flux from the housing to the storage for equides.

33 Livestock::Equides::Excretion

Agrammon Group – 2008-02-22

33.1 Short description

Computes the annual N excretion of horses, mules and asses.

33.2 Input parameters

Parameter	Unit	Description
animalcategory	-	Animal category (horses younger than 3 years, horses older than 3 years, mules, ponies and asses). Possible values: `horses_younger_than_3yr`, `mules`, `ponies_and_asses`, `horses_older_than_3yr`
animals	-	Number of other animals for the selected type in barn.

33.3 Technical parameters

Parameter	Value	Unit	Description
standard_N_excretion_horses-_younger_than_3yr	42	kg N /a	Annual standard N excretion for other animal category (horses younger than 3 years) according to Flisch et al. (2009).
standard_N_excretion_horses-_older_than_3yr	44	kg N /a	Annual standard N excretion for other animal category (horses older than 3 years) according to Flisch et al. (2009).
standard_N_excretion_mules	25.1	kg N /a	Annual standard N excretion for other animal category (mules) according to Flisch et al. (2009).
standard_N_excretion_ponies-_and_asses	15.7	kg N /a	Annual standard N excretion for other animal category (asses and ponies) according to Flisch et al. (2009).
share_Nsol_horses_younger-_than_3yr	0.4	-	Nsol content of excreta from horses younger than 3 years. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_horses_older-_than_3yr	0.4	-	Nsol content of excreta from horses older than 3 years. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_mules	0.4	-	Nsol content of excreta from mules. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_ponies_and_asses	0.4	-	Nsol content of excreta from asses and ponies. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).

33.4 Output

Parameter	Unit	Formula
n_sol_excretion	kg N /a	Annual soluble N excreted by a specified number of animals. Out(share_Nsol) * Out(n_excretion);

standard_N_excretion	kg N /a	Annual standard N excretion for specified other animal category according to Flisch et al. (2009).
		
		my $key = "standard_N_excretion_" . In('animalcategory');
		return Tech($key);

animals	-	Number of other animals for the selected type in barn. In(animals);
n_excretion	kg N /a	Annual N excreted by a specified number of animals. Out(standard_N_excretion) * In(animals);

share_Nsol	-	Nsol content of excreta of other animal category. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
		
		my $key = "share_Nsol_" . In('animalcategory');
		return Tech($key);

33.5 Detailed process description

This process calculated the annual N excretion of the animal categories listed above. The standard N excretion was taken from the official Swiss fertilizer guidelines. The Nsol content of the excreta is based on e.g. Peterson et al. (1998) or Burgos et al. (2005). These values were compiled on the basis of official feeding recommendations (Flisch et al. 2009) by H. Menzi.

33.5.1 References:

Burgos SA, Robinson PH, Fadel JG, DePeters EJ 2005. Ammonia volatilization potential: Prediction of urinary urea nitrogen output on lactating dairy cows. Agriculture, Ecosystems and Environment 111:261-269.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

Flisch R, Sinaj S, Charles R, Richner W 2009. Grundlagen für die die Düngung im Acker- und Futterbau. Agrarforschung 16(2).

34 Livestock::Equides::Grazing

Agrammon Group – 2008-02-22

34.1 Short description

Computes the annual NH3 emission from grazing of equides, such as horses, mules, asses.

34.2 Input parameters

Parameter	Unit	Description
grazing_days	d /a	Average grazing days per year.
grazing_hours	h /d	Average grazing hours per day.

34.3 Technical parameters

Parameter	Value	Unit	Description
er_equides_grazing	0.05	-	Emission rate for the calculation of the annual NH3 emission during grazing of equides. 5% Ntot (conversion with a protion of Nsol of 40%: EF 12.5% TAN). The emission rate is derived from Bussink et al. (1992, 1994), Jarvis et al. (1989), Peterson et al. (1998) and Ross and Jarvis (2001). (taking into account the generally low fertilization rate of Swiss pastures.)

34.4 Output

Parameter	Unit	Formula
grazing_days	d /a	Grazing days per year. In(grazing_days);
nh3_ngrazing	kg N /a	Annual NH3 emission from equides from grazing. Out(n_into_grazing) * Tech(er_equides_grazing);
n_into_grazing	kg N /a	Annual N excretion during grazing for equides. Val(n_excretion, Excretion) * In(grazing_days) / 365 * In(grazing_hours) / 24;
n_remain_pasture	kg N /a	Annual N input on pastures. Out(n_into_grazing) - Out(nh3_ngrazing);
n_sol_into_grazing	kg N /a	Annual solable N (TAN) excretion during grazing for equides. Val(n_sol_excretion, Excretion) * In(grazing_days) / 365 * In(grazing_hours) / 24;
grazing_hours	h /d	Grazing hours per day. In(grazing_hours);

34.5 Detailed process description

This process calculates the annual NH3 emission from grazing of equides (horses, mules, asses) based on the total N excreted on the pastures. The N excreted is calculated according to the time the animals spend on the pasture. It assumes that the excretions on the pasture are proportional to the time the animals are grazed.

34.5.1 References:

Bussink DW 1992. Ammonia volatilization from grassland receiving nitrogen fertilizer and rotationally grazed by dairy cattle. Fertilizer Research 33:257-265.

Bussink DW 1994. Relationship between ammonia volatilization and nitrogen fertilizer application rate, intake and excretion of herbage nitrogen by cattle on grazed swards. Fertilizer Research 38:111-121.

Jarvis SC, Hatch DJ, Lockyer DR 1989. Ammonia fluxes from grazed grassland: annual losses from cattle production systems and their relation to nitrogen inputs. Journal of Agricultural Science 113:99-108.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

Ross CA, Jarvis SC 2001. Measurement of emission and deposition pattern of ammonia from urine in grass swards. Atmospheric environment 35:867-875.

35 Livestock::Equides::Housing

Agrammon Group – 2008-02-22

35.1 Short description

Computes the annual NH3 emission from equides housing systems.

35.2 Input parameters

35.3 Technical parameters

Parameter	Value	Unit	Description
er_housing	0.11	-	Emission rate for loose housing with liquid, solid manure system is assumed (for TAN 0.275 and Nsol 40%).

35.4 Output

Parameter	Unit	Formula
tan_outhousing_liquid	kg N /a	Annual N flux as TAN out of housing, slurry or liquid fraction of N flux. 0
n_outhousing_liquid	kg N /a	Annual N flux out of housing, slurry or liquid fraction of N flux. 0
n_outhousing	kg N /a	Annual N flux out of the housing. Out(n_into_housing) - Out(nh3_nhousing);
n_into_housing	kg N /a	Annual N flux into the house. Val(n_excretion, Excretion) - Val(n_into_grazing, Grazing);
tan_outhousing	kg N /a	Annual N flux as TAN out of the housing. Out(n_sol_into_housing) - Out(nh3_nhousing);
nh3_nhousing	kg N /a	Annual NH3 emission from equides housing systems. per animal place. Val(n_excretion, Excretion) * Tech(er_housing) * Val(k_grazing, Housing::KGrazing)
n_sol_into_housing	kg N /a	Annual N flux as TAN into the house. Val(n_sol_excretion, Excretion) - Val(n_sol_into_grazing, Grazing);
tan_outhousing_solid	kg N /a	Annual N flux as TAN out of housing, manure fraction of N flux. Out(tan_outhousing);
n_outhousing_solid	kg N /a	Annual N flux out of housing, manure fraction of N flux. Out(n_outhousing);

35.5 Detailed process description

This process calculates the NH3 emission in equides housing depending on the N excretion and the housing systems. The NH3 emission is assumed to be proportional to the total N excretion of the animals because the contaminated surfaces will primarily drive emissions, which will remain active even when animals are on the pasture or exercise yard.

A proportional correction is applied according to the area per animal.

A correction is applied if the part of the day grazing is above a defined grazing hours per days.

35.5.1 Definition of System boundaries for the housing Process:

For housing systems with integrated exercise yards, it is difficult to distinguish between emissions from housing, exercise yard and storage. For these housingtypes the emission may be only validated for the sum of housing, exercise yard and storage emission.

36 Livestock::Equides::Housing::KGrazing

Agrammon Group – 2008-04-1

36.1 Short description

Computes the correction factor for the reduction of the housing emission if the number of grazing hours per day does increase a specific limit.

36.2 Input parameters

36.3 Technical parameters

Parameter	Value	Unit	Description
k_grazing_reduction_lw5h	0	-	Reduction of housing emissions to 0% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw12h	0.2	-	Reduction of housing emissions to 20% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw22h	0.5	-	Reduction of housing emissions to 50% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_gt22h	1.0	-	Reduction of housing emissions to 100% due to extensive grazing/alping. Empirical estimation.

36.4 Output

Parameter	Unit	Formula
k_grazing	-	The correction factor for the reduction of the housing emission depending on the number of grazing hours per day and the grazing days per year. if (Val('grazing_hours', '..::Grazing') < 5){ return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_lw5h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } elsif (Val('grazing_hours', '..::Grazing') < 12.0){ return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_lw12h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } elsif (Val('grazing_hours', '..::Grazing') < 22.0) { return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_lw22h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } elsif (Val('grazing_hours', '..::Grazing') >= 22.0) { return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_gt22h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } else { return 1; # no correction };

36.5 Detailed process description

This process calculates the correction factor for the non proportional change of the housing emission according to the grazing hours per day (Webb et al. 2005). It is based on an empirical estimation of Menzi and Katz (1997). The concept has been lately supported by measurements in the UK (Defra 2005), where reductions comparable to those assumed by Menzi and Katz (1997) were reported.

36.5.1 References:

Department for Environment, Food & Rural Affairs, Defra 2002. Ammonia in the UK. DEFRA Publications, London. Menzi H, Katz PE 1997. A differentiated approach to calculate ammonia emissions from animal husbandry. In: Voermans JAM and Monteny GJ (Eds): "Ammonia and odour emissions from animal production facilities", Proc. International Symposium, Vinkeloord, NL, 6-10 October 1997, 35-42. Webb J, Misselbrook TH 2005. A mass-flow model of ammonia emissions from UK livestock production. Atmospheric environment 38: 2163-2176.

37 Livestock::Equides::Yard

Agrammon Group – 2008-03-30

37.1 Short description

Computes the annual NH3 emission from equides on exercise yards based on the access time and if the the basic feeding is on the yard.

37.2 Input parameters

Parameter	Unit	Description
yard_days	d /a	Access to exercise yard in days per year.
yard_hours	h /d	Access to exercise yard in hours per day.
floor_properties_exercise_yard	-	Floor properties (solid_floor, unpaved_floor, paddock_or_pasture_used_as_exercise_yard). Possible values: `paddock_or_pasture_used_as_exercise_yard`, `unpaved_floor`, `solid_floor`

37.3 Technical parameters

Parameter	Value	Unit	Description
er_yard	0.35	-	Emission rate for TAN on yard. Empirical estimation Kupper/Menzi, Keck(1997, Misselbrook et al. (2001)
red_floor_properties_unpaved-_floor	0.5	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties_solid-_floor	0.0	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties_paddock-_or_pasture_used_as-_exercise_yard	0.9	-	Reduction efficiency according to Reidy and Menzi.

37.4 Output

Parameter	Unit	Formula
n_into_yard	kg N /a	Annual N excretion on yard for a defined animal category. Val(n_excretion, Excretion) * ((In('yard_days') / 365) * (In('yard_hours') /24));
tan_outyard_solid	kg N /a	Annual N flux as TAN from solid part out of yard into storage. 0;

nh3_nyard_animal	kg N /a	Annual NH3 emission per anmimal from yard.
		
		if(Val(animals, Excretion) != 0){ return Out(nh3_nyard) / Val(animals, Excretion);
		} else { return 0;
		};

n_sol_into_yard	kg N /a	Annual soluble N excretion on yard for a defined animal category. Val(n_sol_excretion, Excretion) * ((In('yard_days') / 365) * (In('yard_hours') /24));
nh3_nyard	kg N /a	Annual NH3 emission from yard. Out(n_sol_into_yard) * Tech(er_yard) * (1 - (Out(c_floor_properties_exercise_yard)));
n_outyard_liquid	kg N /a	Annual N flux from liquid part out of yard. Out(n_into_yard) - Out(nh3_nyard);
n_outyard_solid	kg N /a	Annual N flux from solid part out of yard. 0;
tan_outyard_liquid	kg N /a	Annual N flux as TAN from liquid part out of yard into storage. Out(n_sol_into_yard) - Out(nh3_nyard);
tan_outyard	kg N /a	Annual N flux as TAN out of yard into storage. Out(n_sol_into_yard) - Out(nh3_nyard);
n_outyard	kg N /a	Annual N flux out of yard. Out(n_into_yard) - Out(nh3_nyard);

c_floor_properties_exercise-_yard	-	Reduction factor for the emission due to the use of the floor properties in housing systems.
		
		if (In('floor_properties_exercise_yard') eq 'unpaved_floor'){ return Tech('red_floor_properties_unpaved_floor');
		} elsif (In('floor_properties_exercise_yard') eq 'solid_floor'){ return Tech('red_floor_properties_solid_floor');
		} elsif (In('floor_properties_exercise_yard') eq 'pad-dock_or_pasture_used_as_exercise_yard'){ return Tech('red_floor_properties_paddock_or_pasture_used_as_exercise_yard');
		} else{ return 0;
		};

37.5 Detailed process description

37.5.1 References:

Keck M 1997: Ammonia emission and odour thresholds of cattle houses with exercise yards. In: Voermans JAM and Monteny GJ (Eds): "Ammonia and odour emissions from animal production facilities", Proc. International Symposium, Vinkeloord, NL, 6-10 October 1997, 349-354. Misselbrook TH, Webb J, Chadwick DR, Ellis S, Pain BF 2001. Gaseous emissions from outdoor concrete yards used by livestock. Atmospheric Environment 35:5331-5338.

38 Livestock::FatteningPigs

Agrammon Group – 2008-02-19

38.1 Short description

Collects the annual emission of NH3 and the N flux for fattening pigs.

38.2 Input parameters

38.3 Technical parameters

38.4 Output

Parameter	Unit	Formula
tan_solid_from_fattening_pig	kg N /a	Annual N flux as TAN from fattening pigs housing, liquid fraction. Val(tan_outhousing_solid, FatteningPigs::Housing);
tan_from_fattening_pig	kg N /a	Annual N flux as TAN from fattening pigs housing. Val(tan_outhousing, FatteningPigs::Housing);
nh3_nfattening_pig	kg N /a	Annual NH3 emission from fattening pigs housing and grazing (production). Val(nh3_nhousing, FatteningPigs::Housing) + Val(nh3_ngrazing, FatteningPigs::Grazing);
n_solid_from_fattening_pig	kg N /a	Annual N flux from fattening pigs housing, solid fraction. Val(n_outhousing_solid, FatteningPigs::Housing);
tan_liquid_from_fattening-_pig	kg N /a	Annual N flux as TAN from fattening pigs housing, liquid fraction. Val(tan_outhousing_liquid, FatteningPigs::Housing);
n_from_fattening_pig	kg N /a	Annual N flux from fattening pigs housing. Val(n_outhousing, FatteningPigs::Housing);
n_excretion	kg N /a	Annual N excreted by fattening pigs. Val(n_excretion, FatteningPigs::Excretion);
n_liquid_from_fattening_pig	kg N /a	Annual N flux from fattening pigs housing, liquid fraction. Val(n_outhousing_liquid, FatteningPigs::Housing);

38.5 Detailed process description

This process summarizes the annual emission of NH3 for fattening pigs from housing and grazing. And it summarizes the annual N flux from housing to the storage for fattening pigs.

39 Livestock::FatteningPigs::Excretion

Agrammon Group – 2008-04-22

39.1 Short description

Computes the annual N excretion of fattening pigs as a function of the crude protein and the energy content of the feed ration.

39.2 Input parameters

Parameter	Unit	Description
fattening_pigs	-	Number of fattening pigs for the selected type in barn.
feeding_phase_1_crude-_protein	g /kg	Crude protein content of feed ration during phase 1.
feeding_phase_2_crude-_protein	g /kg	Crude protein content of feed ration during phase 2.
feeding_phase_3_crude-_protein	g /kg	Crude protein content of feed ration during phase 3.
energy_content	MJ VES /kg	Energy content of feed ration.

39.3 Technical parameters

Parameter	Value	Unit	Description
standard_N_excretion-_fattening_pigs	13	kg N /a	Annual standard N excretion for fattening pigs according to Flisch et al. (2009).
standard_energy_content-_fattening_pigs	13.5	MJ VES	Standard energy content of a feed ration for fattening pigs (BLW, SRVA, LBL 2003).
standard_crude_protein-_fattening_pigs	170	g CP /kg	Standard crude protein content of a feed ration for fattening pigs (BLW, SRVA, LBL 2003).
cfeed_fattening_pigs	0.008	-	Correction factor for feed with reduced crude protein content for fatteing pigs (BLW, SRVA, LBL 2003). A diffrence from 10 g CP /kg leads to 8 0/0 .
minimal_N_excretion-_fattening_pigs	10.9	kg N /a	Annual minimal N excretion for fattening pigs according to Flisch et al. (2009).
share_Nsol	0.7	-	Nsol content of excreta from fattening pigs. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
phase_1_3_duration	0.151	d	Feeding phase 1 of a 3-phase-feeding duration as part of the year.
phase_2_3_duration	0.321	d	Feeding phase 2 of a 3-phase-feeding duration as part of the year.
phase_3_3_duration	0.528	d	feeding phase 3 of a 3-phase-feeding duration as part of the year.
phase_1_2_duration	0.359	d	Feeding phase 1 of a 2-phase-feeding duration as part of the year.
phase_2_2_duration	0.641	d	Feeding phase 2 of a 2-phase-feeding duration as part of the year.

39.4 Output

Parameter	Unit	Formula
n_sol_excretion	kg N /a	Annual soluble N excreted by a specified number of fattening pigs. Tech(share_Nsol) * Out(n_excretion);
minimal_N_excretion	kg N /a	Minimal annual N excretion for fattening pigs according to Walther et al. (2001). Tech(minimal_N_excretion_fattening_pigs);
crude_protein	kg N /a	Crude protein content of feed ration - for 1-, 2- or 3-phase-feeding. if (In(feeding_phase_3_crude_protein) == 0) { if ((In(feeding_phase_1_crude_protein) > 100) && (In(feeding_phase_2_crude_protein) > 100)) { (In(feeding_phase_1_crude_protein)*Tech(phase_1_2_duration)+ In(feeding_phase_2_crude_protein)*Tech(phase_2_2_duration)) } else { if (In(feeding_phase_1_crude_protein) < 100){ In(feeding_phase_1_crude_protein) } else {print STDERR "Crude protein must be more than 1000!"}} } else { if ((In(feeding_phase_1_crude_protein) > 100) && (In(feeding_phase_2_crude_protein) > 100) && (In(feeding_phase_3_crude_protein) > 100)) { (In(feeding_phase_1_crude_protein)*Tech(phase_1_3_duration)+ In(feeding_phase_2_crude_protein)*Tech(phase_2_3_duration)+ In(feeding_phase_3_crude_protein)*Tech(phase_3_3_duration)) } else {print STDERR "Crude protein must be more than 100!" } };
cfeed	-	Correction factor for feed with reduced crude protein content (BLW, SRVA, LBL 2003). Tech(cfeed_fattening_pigs);
standard_crude_protein	g CP /kg	Annual standard N excretion for fattening pigs according to Walther et al. (2001). Tech(standard_crude_protein_fattening_pigs);
fattening_pigs	-	Number of fattening pigs of a specific category. In(fattening_pigs);
standard_N_excretion	kg N /a	Annual standard N excretion for fattening pigs according to Walther et al. (2001). Tech(standard_N_excretion_fattening_pigs);

n_excretion	kg N /a	Annual total N excreted by a specified number of fattening pigs.
		
		if(In('energy_content') != 0){ Out(standard_N_excretion) * (1 - (Out(standard_crude_protein) - Out('crude_protein')) * Out(cfeed)) * (Out(standard_energy_content) / In('energy_content')) * In(fattening_pigs);
		} else { print STDERR "Energy Content can not be 0, use default value!" ;
		return 0;
		};

standard_energy_content	MJ VES	Standard energy content of the feed ration for fattening pigs. Tech(standard_energy_content_fattening_pigs);

39.5 Detailed process description

This process calculates the annual N excretion (total N and Nsol) of fattening pigs according to the crude protein and energy content of the feed ration.

39.5.1 References:

BLW, SRVA, LBL 2003. Weisungen zur Beruecksichtigung von Ökofuttern in der Suisse-Bilanz. 2003.

Burgos SA, Robinson PH, Fadel JG, DePeters EJ 2005. Ammonia volatilization potential: Prediction of urinary urea nitrogen output on lactating dairy cows. Agriculture, Ecosystems and Environment 111:261-269.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

Flisch R, Sinaj S, Charles R, Richner W 2009. Grundlagen für die die Düngung im Acker- und Futterbau. Agrarforschung 16(2).

40 Livestock::FatteningPigs::Grazing

Agrammon Group – 2008-02-29

40.1 Short description

Computes the annual NH3 emission from grazing fattening pigs.

40.2 Input parameters

40.3 Technical parameters

Parameter	Value	Unit	Description
er_fattening_pig_grazing	0.2	-	Emission rate for the calculation of the annual NH3 emission during grazing for fattening pigs. Sommer et al. (2001) give a yearly volatilization loss from one sow with piglets of 4.8 kg N resulting in a loss of 20% TAN assuming an N excretion/sow/y of 35 kg N (Flisch et al. (2009)).

40.4 Output

Parameter	Unit	Formula
nh3_ngrazing	kg N /a	Annual NH3 emission from all fattening pigs from grazing. Out(n_sol_into_grazing) * Tech(er_fattening_pig_grazing);
share_grazing	-	Share of N excretion during outdoor activities for a defined animal category. If fattening pig housing type is 'Outdoor' 100% is assumed. if(Val('housing_type', 'Housing::Type') eq 'Outdoor'){ return 1; }else { return 0; # no correction };
n_into_grazing	kg N /a	Annual N excretion during grazing for fattening pigs. Val('n_excretion', 'Excretion') * Out(share_grazing);
n_remain_pasture	kg N /a	Annual N input on pastures. Out(n_into_grazing) - Out(nh3_ngrazing);
n_sol_into_grazing	kg N /a	Annual soluble N (TAN) excretion during grazing for fattening pigs. Val('n_sol_excretion', 'Excretion') * Out(share_grazing);

40.5 Detailed process description

This process calculates the annual NH3 emission from grazing fattening pigs based on the N excreted on the pastures. The N excreted is calculated according to the time the animals spend on the pasture. It assumes that the excretions on the pasture are proportional to the time the animals are grazed.

40.5.1 References:

Bussink DW 1992. Ammonia volatilization from grassland receiving nitrogen fertilizer and rotationally grazed by dairy cattle. Fertilizer Research 33:257-265.

Bussink DW 1994. Relationship between ammonia volatilization and nitrogen fertilizer application rate, intake and excretion of herbage nitrogen by cattle on grazed swards. Fertilizer Research 38:111-121.

Jarvis SC, Hatch DJ, Lockyer DR 1989. Ammonia fluxes from grazed grassland: annual losses from cattle production systems and their relation to nitrogen inputs. Journal of Agricultural Science 113:99-108.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

Ross CA, Jarvis SC 2001. Measurement of emission and deposition pattern of ammonia from urine in grass swards. Atmospheric environment 35:867-875.

Flisch R, Sinaj S, Charles R, Richner W 2009. Grundlagen für die die Düngung im Acker- und Futterbau. Agrarforschung 16(2).

41 Livestock::FatteningPigs::Housing

Agrammon Group – 2009-02-22

41.1 Short description

Computes the annual NH3 emission from fattening pigs housing systems.

41.2 Input parameters

41.3 Technical parameters

41.4 Output

Parameter	Unit	Formula
tan_outhousing_liquid	kg N /a	Annual N flux as TAN out of housing, slurry or liquid fraction from fattening pigs. if(Val(housing_type, Housing::Type) eq 'Outdoor'){ 0 }else { Out(n_outhousing) * Val('share_liquid', 'Housing::Type') * Out(share_tan_out) };
n_outhousing_liquid	kg N /a	Annual N flux out of housing, slurry or liquid fraction from fattening pigs. if(Val(housing_type, Housing::Type) eq 'Outdoor'){ 0 }else { Out(n_outhousing) * Val('share_liquid', 'Housing::Type') };
n_outhousing	kg N /a	Annual N flux out of the housing. if(Val('housing_type', 'Housing::Type') eq 'Outdoor'){ 0 }else { Out(n_into_housing) - Out(nh3_nhousing) };
n_into_housing	kg N /a	Annual N flux into the house. Val('n_excretion', 'Excretion') - Val('n_into_grazing', 'Grazing');
tan_outhousing	kg N /a	Annual N flux as TAN out of the housing. if(Val(housing_type, Housing::Type) eq 'Outdoor'){ 0 }else { Out(n_sol_into_housing) - Out(nh3_nhousing) };
nh3_nhousing	kg N /a	Annual NH3 emission from fattening pig housing systems. per animal place. Val('n_sol_excretion', 'Excretion') * Val('er_housing', 'Housing::Type') * Val('c_air_scrubber', 'Housing::AirScrubber') * (1 - Val('c_UNECE_housing_task', 'Housing::UNECEhousingTask'));
n_sol_into_housing	kg N /a	Annual N flux as TAN into the house. Val('n_sol_excretion', 'Excretion') - Val('n_sol_into_grazing', 'Grazing');
tan_outhousing_solid	kg N /a	Annual N flux as TAN out of housing, manure fraction of N flux from fattening pigs. if(Val(housing_type, Housing::Type) eq 'Outdoor'){ 0 }else { Out(n_outhousing) * (1 - Val('share_liquid', 'Housing::Type')) * Out(share_tan_out) };
n_outhousing_solid	kg N /a	Annual N flux out of housing, manure fraction of N flux from fattening pigs. if(Val('housing_type', 'Housing::Type') eq 'Outdoor'){ 0 }else { Out(n_outhousing) * (1 - Val('share_liquid', 'Housing::Type')) };
share_tan_out	-	Share of TAN for interface to storage, the same share is assumed for solid and liquid parts of output. Mineralization and immobilization are considerd in the storage module. if(Out(n_outhousing) != 0){ Out(tan_outhousing) / Out(n_outhousing) }else{0};

41.5 Detailed process description

This process calculates the NH3 emission in fattening pig housing depending on the N excretion and the housing systems. The NH3 emission is assumed to be proportional to the total N excretion of the animals because the contaminated surfaces will primarily drive emissions, which will remain active even when animals are on the pasture or exercise yard.

A proportional correction is applied according to the area per animal.

A correction is applied if the part of the day grazing is above a defined grazing hours per days.

41.5.1 Definition of System boundaries for the housing Process:

For housing systems with integrated exercise yards, it is difficult to distinguish between emissions from housing, exercise yard and storage. For these housingtypes the emission may be only validated for the sum of housing, exercise yard and storage emission.

42 Livestock::FatteningPigs::Housing::AirScrubber

Agrammon Group – 2008-03-30

42.1 Short description

Computes the annual NH3 reduction due to an exhaust air scrubber in fattening pig housing systems.

42.2 Input parameters

Parameter	Unit	Description
air_scrubber	-	Air exhaust scrubber (none, acid, biotrickling_filter). Possible values: `acid`, `biotrickling`, `none`

42.3 Technical parameters

Parameter	Value	Unit	Description
red_acid_air_scrubber	0.9	-	Reduction efficiency as compared to group-housed on fully and partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_biotrickling_filter_air-_scrubber	0.7	-	Reduction efficiency as compared to group-housed on fully and partly slatted floors (UNECE 2007, paragraph 71, table 5).

42.4 Output

Parameter	Unit	Formula

c_air_scrubber	-	Reduction factor for the emission due to the use of an air exhaust scrubber in housing systems.
		if (In('air_scrubber') eq 'acid'){ return (1 - Tech('red_acid_air_scrubber'));
		} elsif(In('air_scrubber') eq 'biotrickling'){ return (1 - Tech('red_biotrickling_filter_air_scrubber'));
		} elsif(In('air_scrubber') eq 'none'){ return 1;
		} else{ print STDERR "invalid air_scrubber defined!";
		return 1;
		}

42.5 Detailed process description

This submodul calculates the annual NH3 reduction due to an exhaust air scrubber in fattening pig housing systems according to the UNECE guideline 2007.

42.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. ECE/EB.AIR/WG.5/2007/13.

43 Livestock::FatteningPigs::Housing::Type

Agrammon Group – 2008-02-19

43.1 Short description

Selects the emission rate and other correciton factors for the specific housing types for fattening pigs.

43.2 Input parameters

Parameter	Unit	Description
housing_type	-	Type of housing. Possible values: `Deep_Litter`, `Outdoor`, `Slurry_Label`, `Slurry_Conventional`

43.3 Technical parameters

43.4 Output

Parameter	Unit	Formula
housing_type	-	Housing type (needed in other modules). In(housing_type);
share_liquid	-	Liquid share for the housing type. Val(share_liquid, 'Type::' . In(housing_type));
er_housing	-	Emission rate for the housing type. Val(er_housing, 'Type::' . In(housing_type));
share_solid	-	Solid share for the housing type. Val(share_solid, 'Type::' . In(housing_type));

43.5 Detailed process description

This process selects the correction factor for the specific housing types for fattening pigs. Among these correction factors are the emission rate for the housing type, the correction factor for the housing type area, the correction factor for the area per animal, the liquid and solid share for the housing type as well as the factor on what barn size increases the regularized minimal (limited to 0.5).

44 Livestock::FatteningPigs::Housing::Type::Deep_Litter

Agrammon Group – 2008-04-18

44.1 Short description

Describes correction factors for the label deep litter fattening pig housing system.

44.2 Input parameters

44.3 Technical parameters

Parameter	Value	Unit	Description
er	0.157	-	Emission rate for the label deep litter fattening pig housing system. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 12.81 % Ntot; converted using Nsol of 70%: EF 18.3 % TAN
share_liquid	0	-	For the label deep litter fattening pig housing system 100% of the manure goes into solid manure storage/application.

44.4 Output

Parameter	Unit	Formula
share_liquid	-	Liquid part of Ntot for selected housing type. Tech(share_liquid);
er_housing	-	Emission rate for specific housing type. Tech(er);
share_solid	-	Solid part of Ntot for selected housing type. 1-Tech(share_liquid);

44.5 Detailed process description

This process describes the correction factors for the label deep litter fattening pig housing system such as the housing specific emission rate, the liquid share and solid share.

45 Livestock::FatteningPigs::Housing::Type::Outdoor

Agrammon Group – 2008-04-18

45.1 Short description

Describes emission rates for outdoor fattening pigs. Outdoor fattening pics do not have any housing emissions.

45.2 Input parameters

45.3 Technical parameters

Parameter	Value	Unit	Description
er	0	-	Emission rate for outdoor fattening pigs (equal to zero because all emissions are listed under grazing).
share_liquid	0	-	For the outdoor fattening pigs 0% of the manure goes into the liquid fraction for storage/application.

45.4 Output

Parameter	Unit	Formula
share_liquid	-	Liquid part of Ntot for selected housing type. Tech(share_liquid);
er_housing	-	Emission rate for specific housing type. Tech(er);
share_solid	-	For the outdoor fattening pigs 0% of the manure goes into the solid fraction for storage/application. 0

45.5 Detailed process description

This process describes the correction factors for outdoor fattening pigs such as the housing specific emission rate, the liquid share and solid share. Outodoor fattening pigs do not have any housing emissions, as everything is excreted on pasture.

46 Livestock::FatteningPigs::Housing::Type::Slurry_Conventional

Agrammon Group – 2008-04-18

46.1 Short description

Describes correction factors for the conventional slurry fattening pig housing system.

46.2 Input parameters

46.3 Technical parameters

Parameter	Value	Unit	Description
er	0.243	-	Emission rate for the conventional slurry fattening pig housing system. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 17 % Ntot; converted using Nsol of 70%: EF 24.3 % TAN.
share_liquid	1	-	For the conventional slurry fattening pig housing system 100% of the manure goes into the liquid fraction for storage/application.

46.4 Output

Parameter	Unit	Formula
share_liquid	-	Liquid part of Ntot for selected housing type. `Tech(share_liquid);`
er_housing	-	Emission rate for specific housing type. `Tech(er);`
share_solid	-	Solid part of Ntot for selected housing type. `1-Tech(share_liquid);`

46.5 Detailed process description

This process describes the correction factors for the conventional slurry fattening pig housing system such as the housing specific emission rate, the liquid share and solid share.

47 Livestock::FatteningPigs::Housing::Type::Slurry_Label

Agrammon Group – 2008-04-18

47.1 Short description

Describes correction factors for the label slurry fattening pig housing system.

47.2 Input parameters

47.3 Technical parameters

Parameter	Value	Unit	Description
er	0.486	-	Emission rate for the label slurry fattening pig housing system. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 34 % Ntot; converted using Nsol of 70%: EF 48.6 % TAN.
share_liquid	1	-	For the label slurry fattening pig housing system 100% of the manure goes into the liquid fraction for storage/application.

47.4 Output

Parameter	Unit	Formula
share_liquid	-	Liquid part of Ntot for selected housing type. `Tech(share_liquid);`
er_housing	-	Emission rate for specific housing type. `Tech(er);`
share_solid	-	Solid part of Ntot for selected housing type. `1-Tech(share_liquid);`

47.5 Detailed process description

This process describes the correction factors for the label slurry fattening pig housing system such as the housing specific emission rate, the liquid share and solid share.

48 Livestock::FatteningPigs::Housing::UNECEhousingTask

Agrammon Group – 2008-03-30

48.1 Short description

Computes the annual NH3 reduction due to UNECE housing tasks.

48.2 Input parameters

Parameter	Unit	Description
UNECE_category_1-_mitigation_options_for-_housing_systems_for-_fattening_pigs	-	UNECE housing tasks for partly slatted floor: with scraper (concrete_slats), with flush channels(no areation), with flush channels(areation), with flush gutters/tubes (no areation), with flush gutters/tubes (areation), with channels slanted walls(concrete slats), with channel slanted walls (metal slats), with scraper (metal slats). Possible values: `with_channel_slanted_walls_metal_slats`, `with_channels_slanted_walls_concrete_slats`, `with_flush_channels_areation`, `with_flush_channels_no_areation`, `with_flush_gutters_tubes_areation`, `with_flush_gutters_tubes_no_areation`, `with_scraper_concrete_slats`, `with_scraper_metal_slats`, `none`

48.3 Technical parameters

Parameter	Value	Unit	Description
red_PSF_with_scraper-_concrete_slats	0.4	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush-_channels_no_areation	0.5	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush-_channels_areation	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush_gutters-_tubes_no_areation	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush_gutters-_tubes_areation	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_channels-_slanted_walls_concrete_slats	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_channel-_slanted_walls_metal_slats	0.65	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_with_scraper-_metal_slats	0.5	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).

48.4 Output

Parameter	Unit	Formula

c_UNECE_housing_task	-	Reduction factor for the emission due to UNECE housing systems tasks for fully and partly slatted floors.
		
		if (In('UNECE_category_1_mitigation_options_for_housing_systems_for_fattening_p
		eq "with_scraper_concrete_slats"){ return
		Tech('red_PSF_with_scraper_concrete_slats');
		} elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_fattenin
		eq "with_flush_channels_no_areation"){ return
		Tech('red_PSF_with_flush_channels_no_areation');
		} elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_fattenin
		eq "with_flush_channels_areation"){ return
		Tech('red_PSF_with_flush_channels_areation');
		} elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_fattenin
		eq "with_flush_gutters_tubes_no_areation"){ return
		Tech('red_PSF_with_flush_gutters_tubes_no_areation');
		} elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_fattenin
		eq "with_flush_gutters_tubes_areation"){ return
		Tech('red_PSF_with_flush_gutters_tubes_areation');
		} elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_fattenin
		eq "with_channels_slanted_walls_concrete_slats"){ return
		Tech('red_PSF_with_channels_slanted_walls_concrete_slats');
		} elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_fattenin
		eq "with_channel_slanted_walls_metal_slats"){ return
		Tech('red_PSF_with_channel_slanted_walls_metal_slats');
		} elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_fattenin
		eq "with_scraper_metal_slats"){ return
		Tech('red_PSF_with_with_scraper_metal_slats');
		} elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_fattenin
		eq "none"){ return 0;
		};

48.5 Detailed process description

This submodul calculates the annual NH3 reduction due to an air exhaust scrubber in fattening pig housing systems according to the UNECE guideline 2007.

48.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. ECE/EB.AIR/WG.5/2007/13.

49 Livestock::OtherCattle

Agrammon Group – 2008-02-29

49.1 Short description

Collects the annual emission of NH3 and the N flux for cattle (apart from dairy cows).

49.2 Input parameters

49.3 Technical parameters

49.4 Output

Parameter	Unit	Formula
nh3_ncattle	kg N /a	Annual NH3 emission from cattle housing, yard and grazing (production). Val(nh3_nhousing, OtherCattle::Housing) + Val(nh3_nyard, OtherCattle::Yard) + Val(nh3_ngrazing, OtherCattle::Grazing);
tan_solid_from_cattle	kg N /a	Annual N flux as TAN from cattle housing and yard, solid fraction. Val(tan_outhousing_solid, OtherCattle::Housing) + Val(tan_outyard_solid, OtherCattle::Yard);
tan_from_cattle	kg N /a	Annnual N flux as TAN from cattle housing and yard. Val(tan_outhousing, OtherCattle::Housing) + Val(tan_outyard, OtherCattle::Yard);
tan_liquid_from_cattle	kg N /a	Annual N flux as TAN from cattle housing and yard, liquid fraction. Val(tan_outhousing_liquid, OtherCattle::Housing) + Val(tan_outyard_liquid, OtherCattle::Yard);
n_excretion	kg N /a	Annual N excreted by cattle. Val(n_excretion, OtherCattle::Excretion);
n_liquid_from_cattle	kg N /a	Annual N flux from cattle housing and yard, liquid fraction. Val(n_outhousing_liquid, OtherCattle::Housing) + Val(n_outyard_liquid, OtherCattle::Yard);
n_solid_from_cattle	kg N /a	Annual N flux from cattle housing and yard, solid fraction. Val(n_outhousing_solid, OtherCattle::Housing) + Val(n_outyard_solid, OtherCattle::Yard);
n_from_cattle	kg N /a	Annual N flux from cattle housing and yard. Val(n_outhousing, OtherCattle::Housing) + Val(n_outyard, OtherCattle::Yard);

49.5 Detailed process description

This process summarizes the annual emission of NH3 for cattle (apart from dairy cows) from housing, yard and grazing. Further it summarizes the annual N flux from housing and yard to the storage for cattle.

50 Livestock::OtherCattle::Excretion

Agrammon Group – 2008-02-28

50.1 Short description

Computes the annual N excretion of cattle (apart from dairy cows) as a function of the feed ration.

50.2 Input parameters

Parameter	Unit	Description
animalcategory	-	Animal category (suckling cows, 1 year old heifers, 2 years old heifers, 3 years old heifers, fattening calves, calves of suckling cows, beef cattle). Possible values: `beef_cattle`, `calves_suckling_cows`, `fattening_calves`, `heifers_1st_yr`, `heifers_2nd_yr`, `heifers_3rd_yr`, `suckling_cows`
animals	-	Number of animals for the selected type in barn.

50.3 Technical parameters

Parameter	Value	Unit	Description
standard_N_excretion_heifers_1st_yr	25	kg N /a	Annual standard N excretion for a 1 year old heifer, according to Flisch et al. (2009).
standard_N_excretion_heifers_2nd_yr	40	kg N /a	Annual standard N excretion for a 2 year old heifer, according to Flisch et al. (2009).
standard_N_excretion_heifers_3rd_yr	55	kg N /a	Annual standard N excretion for a 3 year old heifer, according to Flisch et al. (2009).
standard_N_excretion_beef_cattle	33	kg N /a	Annual standard N excretion for a beefcattle, according to Flisch et al. (2009).
standard_N_excretion_fattening_calves	13	kg N /a	Annual standard N excretion for a fattening-calves, according to Flisch et al. (2009).
standard_N_excretion_suckling_cows	80	kg N /a	Annual standard N excretion for a suckling cow, according to Flisch et al. (2009).
standard_N_excretion_calves_suckling_cows	34	kg N /a	Annual standard N excretion for calves of suckling cows, according to Flisch et al. (2009).
share_Nsol_heifers_1st_yr	0.6	-	Nsol content of excreta for 1 year old heifers. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_heifers_2nd_yr	0.6	-	Nsol content of excreta for 2 years old heifers. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_heifers_3rd_yr	0.6	-	Nsol content of excreta for 3 years old heifers. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_beef_cattle	0.6	-	Nsol content of excreta for beefcattle. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_fattening_calves	0.6	-	Nsol content of excreta for fatteningcalves. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_suckling_cows	0.6	-	Nsol content of excreta for suckling cows. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).

share_Nsol_calves_suckling-_cows	0.6	-	Nsol content of excreta for suckling cows. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).

50.4 Output

Parameter	Unit	Formula
n_sol_excretion	kg N /a	Annual soluble N excreted by an animalgroup of selected cattle category. `Out(share_Nsol) * Out(n_excretion);`
n_excretion_animal	kg N /a	Annual mean total N excreted of an animal of selected cattle category. `Out(standard_N_excretion);`

standard_N_excretion	kg N /a	Annual standard N excretion for specified animal category according to Flisch et al. (2009).
		`my $key = "standard_N_excretion_" . In('animalcategory');`
		`return Tech($key);`

animals	-	Number of animals for the selected cattle category in barn. `In(animals);`
n_excretion	kg N /a	Annual total N excreted by an animalgroup of selected cattle category. `Out(standard_N_excretion) * In(animals);`

share_Nsol	-	Nsol content of excreta for a specific cattle category. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
		`my $key = "share_Nsol_" . In('animalcategory');`
		`return Tech($key);`

50.5 Detailed process description

This process calculates the annual N excretion of a number of cattle as a function of the supplied feed ration. The standard N excretion was taken from the official Swiss fertilizer guidelines. The Nsol content of the excreta is based on e.g. Peterson et al. (1998) or Burgos et al. (2005). These values were compiled on the basis of official feeding recommendations (Flisch et al. 2009) by H. Menzi. A detailed documentation will be prepared in the framework of the new revision of the document in the course of summer 2007.

50.5.1 References:

Burgos SA, Robinson PH, Fadel JG, DePeters EJ 2005. Ammonia volatilization potential: Prediction of urinary urea nitrogen output on lactating dairy cows. Agriculture, Ecosystems and Environment 111:261-269.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

Flisch R, Sinaj S, Charles R, Richner W 2009. Grundlagen für die die Düngung im Acker- und Futterbau. Agrarforschung 16(2).

51 Livestock::OtherCattle::Grazing

Agrammon Group – 2008-04-23

51.1 Short description

Computes the annual NH3 emission from grazing cattle.

51.2 Input parameters

Parameter	Unit	Description
grazing_days	d /a	Average grazing days per year.
grazing_hours	h /d	Average grazing hours per day.

51.3 Technical parameters

Parameter	Value	Unit	Description
er_cattle_grazing	0.05	-	Emission rate for the calculation of the annual NH3 emission during grazing for cattle. 5% Ntot (conversion with a portion of Nsol of 60%: EF 8.3% TAN; value based on Table 1 (Mean emission rate of 3.1% N excreted; range: 1.6-5.7% for grazing cows on a sward fertilized with 250 kg N/y) of Bussink (1992) and Table 3 (Mean emission rate of 3.3% N excreted; range: 0.0-7.4% for grazing cows on a sward fertilized with 250 kg N/y) of Bussink (1994). The corresponding value is rather lower for Switzerland since the level of fertilization is lower resulting in a lower level for crude protein. The N level in the fodder of the sward fertilized with 250 kg N/y (31 g/kg d.m.; Table 4) is comparable to values common for Switzerland (Bussink (1994). The EF chosen includes a safety margin.

51.4 Output

Parameter	Unit	Formula
grazing_days	d /a	Grazing days per year. In(grazing_days);
nh3_ngrazing	kg N /a	Annual NH3 emission from all grazing cattle. Out(n_into_grazing) * Tech(er_cattle_grazing);
n_into_grazing	kg N /a	Annual N excretion during grazing for a defined cattle category. Val(n_excretion, Excretion) * In(grazing_days) / 365 * In(grazing_hours) / 24;
n_remain_pasture	kg N /a	Annual N input on pastures. Out(n_into_grazing) - Out(nh3_ngrazing);

nh3_ngrazing_animal	kg N /a	Annual NH3 emission per cattle form grazing.
		
		if(Val(animals, Excretion) != 0){ return Out(nh3_ngrazing) / Val(animals, Excretion);
		} else { return 0;
		};

n_sol_into_grazing	kg N /a	Annual soluble N (TAN) excretion during grazing for a defined cattle category. Val(n_sol_excretion, Excretion) * In(grazing_days) / 365 * In(grazing_hours) / 24;
grazing_hours	h /d	Grazing hours per day. In(grazing_hours);

51.5 Detailed process description

This process calculates the annual NH3 emission from grazing cattle based on the total N excreted on the pastures. The N excreted is calculated according to the time the animals spend on the pasture. It assumes that the excretions on the pasture are proportional to the time the animals are grazed.

51.5.1 References:

Bussink DW 1992. Ammonia volatilization from grassland receiving nitrogen fertilizer and rotationally grazed by dairy cattle. Fertilizer Research 33:257-265.

Bussink DW 1994. Relationship between ammonia volatilization and nitrogen fertilizer application rate, intake and excretion of herbage nitrogen by cattle on grazed swards. Fertilizer Research 38:111-121.

Jarvis SC, Hatch DJ, Lockyer DR 1989. Ammonia fluxes from grazed grassland: annual losses from cattle production systems and their relation to nitrogen inputs. Journal of Agricultural Science 113:99-108.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

Ross CA, Jarvis SC 2001. Measurement of emission and deposition pattern of ammonia from urine in grass swards. Atmospheric environment 35:867-875.

52 Livestock::OtherCattle::Housing

Agrammon Group – 2008-04-22

52.1 Short description

Computes the annual NH3 emission from cattle housing systems.

52.2 Input parameters

52.3 Technical parameters

52.4 Output

Parameter	Unit	Formula
tan_outhousing_liquid	kg N /a	Annual N flux as TAN out of housing, slurry or liquid fraction from cattle. Out(n_outhousing) * Val(share_liquid, Housing::Type) * Out(share_tan_out);
n_outhousing_liquid	kg N /a	Annual N flux out of housing, slurry or liquid fraction from cattle. Out(n_outhousing) * Val(share_liquid, Housing::Type);
n_outhousing	kg N /a	Annual N flux out of housing. Out(n_into_housing) - Out(nh3_nhousing);
n_into_housing	kg N /a	Annual N flux into the house. Val(n_excretion, Excretion) - Val(n_into_grazing, Grazing) - Val(n_into_yard, Yard);
tan_outhousing	kg N /a	Annual N flux as TAN out of housing. Out(n_sol_into_housing) - Out(nh3_nhousing);
nh3_nhousing	kg N /a	Annual NH3 emission from cattle housing systems per animal place. Val(n_sol_excretion, Excretion) * Val(k_grazing, Housing::KGrazing) * Val(er_housing, Housing::Type) * Val(k_area, Housing::Type) * Val(c_UNECE, Housing::Floor);
n_sol_into_housing	kg N /a	Annual N flux as TAN into the house. Val(n_sol_excretion, Excretion) - Val(n_sol_into_grazing, Grazing) - Val(n_sol_into_yard, Yard);
tan_outhousing_solid	kg N /a	Annual N flux as TAN out of housing, solid manure fraction of N flux. Out(n_outhousing) * (1 - Val(share_liquid, Housing::Type)) * Out(share_tan_out);
n_outhousing_solid	kg N /a	Annual N flux out of housing, solid manure fraction of N flux. Out(n_outhousing) * (1 - Val(share_liquid, Housing::Type));
share_tan_out	-	Share of TAN for interface to storage, the same share is assumed for solid and liquid parts of output. Mineralization and immobilization are considerd in the storage module. if(Out(n_outhousing) != 0){ Out(tan_outhousing) / Out(n_outhousing) }else{0};

52.5 Detailed process description

This process calculates the NH3 emission in cattle housing depending on the N excretion and the housing systems. The NH3 emission is assumed to be proportional to the total N excretion of the animals because the contaminated surfaces will primarily drive emission, which will remain active even when animals are on the pasture or exercise yard.

A proportional correction is applied according to the area per animal.

A correction is applied if the part of the day grazing is above a defined grazing hours per days.

52.5.1 Definition of System boundaries for the housing Process:

For housing systems with integrated exercise yards, it is difficult to distinguish between emissions from housing, exercise yard and storage. For these housingtypes the emission may be only validated for the sum of housing, exercise yard and storage emission.

53 Livestock::OtherCattle::Housing::Floor

Agrammon Group – 2008-03-30

53.1 Short description

Computes the annual NH3 reduction due to a grooved floor in cattle housing systems.

53.2 Input parameters

Parameter	Unit	Description
UNECE_category_1-_mitigation_options_for-_housing_systems_for_other-_cattle	-	UNECE category 1 mitigation options for housing systems for other cattle (none, toothed scrapper running over a grooved floor). Possible values: `toothed_scrapper_running_over_a_grooved_floor`, `none`

53.3 Technical parameters

Parameter	Value	Unit	Description
red_UNECE	0.25	-	Reduction efficiency as comppared to cubicle house (UNECE 2007, paragraph 57, table 4).

53.4 Output

Parameter	Unit	Formula

c_UNECE	-	Reduction factor for the emission due to the use of a grooved floor in housing systems.
		if (In('UNECE_category_1_mitigation_options_for_housing_systems_for_other_cattl
		eq 'toothed_scrapper_running_over_a_grooved_floor'){ return (1
		- Tech('red_UNECE'));
		} else { return 1;
		};

53.5 Detailed process description

This submodul calculates the annual NH3 reduction due to a grooved floor in cattle housing systems according to the UNECE guideline 2007.

53.5.1 References

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. ECE/EB.AIR/WG.5/2007/13.

54 Livestock::OtherCattle::Housing::KGrazing

Agrammon Group – 2008-04-1

54.1 Short description

Computes the correction factor for the reduction of the housing emission if the number of grazing hours per day does increase a specific limit.

54.2 Input parameters

54.3 Technical parameters

Parameter	Value	Unit	Description
k_grazing_reduction_lw5h	0	-	Reduction of housing emissions to 0% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw12h	0.2	-	Reduction of housing emissions to 20% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw22h	0.5	-	Reduction of housing emissions to 50% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_gt22h	1.0	-	Reduction of housing emissions to 100% due to extensive grazing/alping. Empirical estimation.

54.4 Output

Parameter	Unit	Formula
k_grazing	1	The correction factor for the reduction of the housing emission depending on the number of grazing hours per day and the grazing days per year. if (Val('grazing_hours', '..::Grazing') < 5){ return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_lw5h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } elsif (Val('grazing_hours', '..::Grazing') < 12.0){ return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_lw12h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } elsif (Val('grazing_hours', '..::Grazing') < 22.0) { return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_lw22h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } elsif (Val('grazing_hours', '..::Grazing') >= 22.0) { return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_gt22h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } else { return 1; # no correction };

54.5 Detailed process description

This process calculates the correction factor for the non proportional change of the housing emissions according to the grazing hours per day (Webb et al. 2005). It is based on an empirical estimation of Menzi and Katz (1997). The concept has been lately supported by measurements in the UK (Defra 2005), where reductions comparable to those assumed by Menzi and Katz (1997) were reported.

54.5.1 References:

Department for Environment, Food & Rural Affairs, Defra 2002. Ammonia in the UK. DEFRA Publications, London. Menzi H, Katz PE 1997. A differentiated approach to calculate ammonia emissions from animal husbandry. In: Voermans JAM and Monteny GJ (Eds): "Ammonia and odour emissions from animal production facilities", Proc. International Symposium, Vinkeloord, NL, 6-10 October 1997, 35-42. Webb J, Misselbrook TH 2005. A mass-flow model of ammonia emissions from UK livestock production. Atmospheric environment 38: 2163-2176.

55 Livestock::OtherCattle::Housing::Type

Agrammon Group – 2008-02-19

55.1 Short description

Selects the emission rate and other correction factors for the specific housing types for cattle.

55.2 Input parameters

Parameter	Unit	Description
housing_type	-	Type of housing. Possible values: `Loose_Housing_Deep_Litter`, `Loose_Housing_Slurry`, `Loose_Housing_Slurry_Plus_Solid_Manure`, `Tied_Housing_Slurry_Plus_Solid_Manure`, `Tied_Housing_Slurry`
dimensioning_barn	-	Number of available animal places.

55.3 Technical parameters

55.4 Output

Parameter	Unit	Formula
housing_type	-	Housing type (needed in other modules). In('housing_type');

area_increase	-	Factor on what barn size does increase the regularized minimal, limited to 0.5
		
		if((Val('animals', '..::Excretion') < In('dimensioning_barn')) and (Val('animals', '..::Excretion') != 0)){ if(In('dimensioning_barn') >= (Val(animals, '..::Excretion') * 1.5)){ return 0.5;
		} else { return((In('dimensioning_barn') / Val(animals, '..::Excretion')) -1);
		} } else { return 0.0;
		};

share_liquid	-	Liquid share for the housing type. Val(share_liquid, 'Type::' . In('housing_type'));
er_housing	-	Emission rate for the housing type. Val('er_housing', 'Type::' . In('housing_type'));
k_area_type	-	Correction factor for the housing type area. Val('k_area', 'Type::' . In('housing_type'));
share_solid	-	Solid share for the housing type. Val(share_solid, 'Type::' . In('housing_type'));
k_area	-	Correction factor for area per animal. 1 + (Out(area_increase) * Out(k_area_type));

55.5 Detailed process description

This process selects the correction factor for the specific housing types for cattle. Among these correction factors are the emission rate for the housing type, the correction factor for the housing type area, the correction factor for the area per animal, the liquid and solid share for the housing type as well as the factor on what barn size increases the regularized minimal (limited to 0.5).

56 Livestock::OtherCattle::Housing::Type::Loose_Housing_Deep-_Litter

Agrammon Group – 2008-04-18

56.1 Short description

Describes correction factors for the loose housing deep litter system.

56.2 Input parameters

56.3 Technical parameters

Parameter	Value	Unit	Description
er	0.183	-	Emission rate for the loose housing deep litter system for cattle. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 11% Ntot; converted using Nsol of 60%: EF 18.3% TAN. Reference value UNECE(2007): 11 kg NH3 = 8% TAN.
share_liquid	0	-	For the loose housing deep litter system 100% of the manure does into the solid manure storage/application.
k_area	0.5	-	According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: it is assumed that additional surfaces are entirely used since barriers are hardly fea-sible. The emission is increased by 5% per 10% of additional surfaces up to a maximum of 50% additional surface.

56.4 Output

Parameter	Unit	Formula
share_liquid	-	Part of Ntot flowing into liquid storage for selected housing type. `Tech(share_liquid);`
er_housing	-	Emission rate for specific housing type. `Tech(er);`
share_solid	-	Share of solid manure of Ntot for selected housing type. `1-Tech(share_liquid);`
k_area	-	Correction factor for area per animal. `Tech(k_area);`

56.5 Detailed process description

This process describes the correction factors for the loose housing deep litter system such as the housing specific emission rate, the area per animal correction, the liquid share and solid share.

56.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. UNECE executive body for the convention on long-range transboundary air pollution, Working Group on Strategies and Review, EB.AIR/WH.5/2007/13/ 16 July 2007, Genf. 35p.

57 Livestock::OtherCattle::Housing::Type::Loose_Housing_Slurry

Agrammon Group – 2008-04-18

57.1 Short description

Describes correction factors for the loose housing slurry system.

57.2 Input parameters

57.3 Technical parameters

Parameter	Value	Unit	Description
er	0.183	-	Emission rate for the loose housing slurry system for cattle. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 11% Ntot; converted using Nsol of 60%: EF 18.3% TAN. Reference value UNECE(2007): 11 kg NH3 = 8% TAN.
share_liquid	1	-	For the loose housing slurry system 100% of the manure goes into the liquid fraction of the storage/application.
k_area	0.5	-	According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: it is assumed that additional surfaces are entirely used since barriers are hardly fea-sible. The emission is increased by 5% per 10% of additional surfaces up to a maximum of 50% additional surface.

57.4 Output

Parameter	Unit	Formula
share_liquid	-	Part of Ntot flowing into liquid storage for selected housing type. `Tech(share_liquid);`
er_housing	-	Emission rate for specific housing type. `Tech(er);`
share_solid	-	Share of solid manure of Ntot for selected housing type. `1-Tech(share_liquid);`
k_area	-	Correction factor for area per animal. `Tech(k_area);`

57.5 Detailed process description

This process describes the correction factors for the loose housing slurry system such as the housing specific emission rate, the area per animal correction, the liquid share and solid share.

57.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. UNECE executive body for the convention on long-range transboundary air pollution, Working Group on Strategies and Review, EB.AIR/WH.5/2007/13/ 16 July 2007, Genf. 35p.

58 Livestock::OtherCattle::Housing::Type::Loose_Housing_Slurry-_Plus_Solid_Manure

Agrammon Group – 2008-04-18

58.1 Short description

Describes correction factors for the loose housing liquid solid system.

58.2 Input parameters

58.3 Technical parameters

Parameter	Value	Unit	Description
er	0.183	-	Emission rate for the loose housing liquid solid system for cattle. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 11% Ntot; convered using Nsol of 60%: EF 18.3% TAN. Reference value UNECE(2007): 11 kg NH3 = 8% TAN.
share_liquid	0.57	-	For the loose housing liquid solid system 57% of the manure goes into the liquid manure storage.
k_area	0.5	-	According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: it is assumed that additional surfaces are entirely used since barriers are hardly fea-sible. The emission is increased by 5% per 10% of additional surfaces up to a maximum of 50% additional surface.

58.4 Output

Parameter	Unit	Formula
share_liquid	-	Part of Ntot flowing into liquid storage for selected housing type. Tech(share_liquid),
er_housing	-	Emission rate for specific housing type. Tech(er),
share_solid	-	Share of solid manure of Ntot for selected housing type. 1-Tech(share_liquid);
k_area	-	Correction factor for area per animal. Tech(k_area);

58.5 Detailed process description

This process describes the correction factors for the loose housing liquid solid system such as the housing specific emission rate, the area per animal correction, the liquid share and solid share.

58.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. UNECE executive body for the convention on long-range transboundary air pollution, Working Group on Strategies and Review, EB.AIR/WH.5/2007/13/ 16 July 2007, Genf. 35p.

59 Livestock::OtherCattle::Housing::Type::Tied_Housing_Slurry

Agrammon Group – 2008-04-18

59.1 Short description

Describes correction factors for the tide housing slurry system.

59.2 Input parameters

59.3 Technical parameters

Parameter	Value	Unit	Description
er	0.067	Missing unit	Emission rate for the tide housing slurry system for cattle. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 4% Ntot, converted using Nsol of 60%: EF 6.7% TAN.
share_liquid	1	-	For the tide housing slurry system 100% of the manure goes into the liquid fraction of the storage/application.
k_area	0	-	Additional surfaces are not used.

59.4 Output

Parameter	Unit	Formula
share_liquid	-	Part of Ntot flowing into liquid storage for selected housing type. Tech(share_liquid);
er_housing	-	Emission rate for specific housing type. Tech(er);
share_solid	-	Share of solid manure of Ntot for selected housing type. 1-Tech(share_liquid);
k_area	-	Correction factor for area per animal. Tech(k_area);

59.5 Detailed process description

This process describes the correction factors for the tied housing slurry system such as the housing specific emission rate, the area per animal correction, the liquid share and solid share.

60 Livestock::OtherCattle::Housing::Type::Tied_Housing_Slurry-_Plus_Solid_Manure

Agrammon Group – 2008-04-18

60.1 Short description

Describes correciton factors for the tide housing liquid solid system.

60.2 Input parameters

60.3 Technical parameters

Parameter	Value	Unit	Description
er	0.067	-	Emisssion rate for the tide housing liquid solid system for cattle. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 4% Ntot; converted using Nsol of 60%: EF 6.7% TAN.
share_liquid	0.57	-	For the tide housing liquid solid system 57% of the manure goes into the liquid fraction of the storage/application.
k_area	0	-	Additional surfaces are not used.

60.4 Output

Parameter	Unit	Formula
share_liquid	-	Part of Ntot flowing into liquid storage for selected housing type. Tech(share_liquid);
er_housing	-	Emission rate for specific housing type. Tech(er);
share_solid	-	Share of solid manure of Ntot for selected housing type. 1-Tech(share_liquid);
k_area	-	Correction factor for area per animal. Tech(k_area);

60.5 Detailed process description

This process describes the correction factors for the tied housing liquid solid system such as the housing specific emission rate, the area per animal correction, the liquid share and solid share.

61 Livestock::OtherCattle::Yard

Agrammon Group – 2008-04-08

61.1 Short description

Computes the annual NH3 emission from cattle (apart from dairy cows) on exercise yards. Based on the access time and if the the basic feeding is on the yard.

61.2 Input parameters

Parameter	Unit	Description
yard_days	d /a	Access to exercise yards days per year.
exercise_yard	-	Exercise yard: not available, available: roughage is not supplied in the exercise yard, available: roughage is partly supplied in the exercise yard, available: roughage is exclusively supplied in the exercise yard. Possible values: `available_roughage_is_exclusively_supplied_in_the_exercise_yard`, `available_roughage_is_not_supplied_in_the_exercise_yard`, `available_roughage_is_partly_supplied_in_the_exercise_yard`, `not_available`
floor_properties_exercise_yard	-	Floor properties(solid floor, unpaved floor, perforated floor, paddock or pasture used as exercise yard). Possible values: `paddock_or_pasture_used_as_exercise_yard`, `perforated_floor`, `unpaved_floor`, `solid_floor`

61.3 Technical parameters

Parameter	Value	Unit	Description
er_yard	0.7	-	Emission rate for TAN on yard.
share_available_roughage_is-_exclusively_supplied_in_the-_exercise_yard	0.6	-	Share of excretion per day for animals with roughage exclusively on the yard.
share_available_roughage_is-_partly_supplied_in_the-_exercise_yard	0.2	-	Share of excretion per day for animals with roughage partly on the yard.
share_available_roughage-_is_not_supplied_in_the-_exercise_yard	0.1	-	Share of excretion per day for animals with roughage not supplied in the yard.
red_floor_properties_solid-_floor	0.0	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties_unpaved-_floor	0.5	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties-_perforated_floor	0.8	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties_paddock-_or_pasture_used_as-_exercise_yard	0.9	-	Reduction efficiency according to Reidy and Menzi.

61.4 Output

Parameter	Unit	Formula
n_into_yard	kg N /a	Annual N excretion on yard for a defined animal category. Val('n_excretion', Excretion) * In('yard_days') / 365 * Out(share_excretion_yard);
tan_outyard_solid	kg N /a	Annual N flux as TAN from solid part out of yard into storage. 0;

nh3_nyard_animal	kg N /a	Annual NH3 emission per anmimal from yard.
		
		if(Val('animals', Excretion) != 0){ return Out('nh3_nyard') / Val('animals', Excretion);
		} else { return 0;
		};

share_excretion_yard	-	Share of excretion on the yard according the stay on yard. If the basic feeding is on the yard the share_basicfeeding is assumed. Otherwise the share is selected according to the access.
		
		if(In('exercise_yard') eq 'available_roughage_is_not_supplied_in_the_exercise_yard') { return Tech('share_available_roughage_is_not_supplied_in_the_exercise_yard');
		} elsif(In('exercise_yard') eq 'available_roughage_is_partly_supplied_in_the_exercise_yard') { return Tech('share_available_roughage_is_partly_supplied_in_the_exercise_yard'
		} elsif(In('exercise_yard') eq 'available_roughage_is_exclusively_supplied_in_the_exercise_yard') { return Tech('share_available_roughage_is_exclusively_supplied_in_the_exercise_
		} elsif(In('exercise_yard') eq 'not_available') { return 0;
		};

nh3_nyard	kg N /a	Annual NH3 emission from yard. Out('n_sol_into_yard') * Tech(er_yard) *(1 - (Out('c_floor_properties_exercise_yard')));
n_outyard	kg N /a	Annual N flux out of yard. Out('n_into_yard') - Out('nh3_nyard');
n_sol_into_yard	kg N /a	Annual soluble N excretion on yard for a defined animal category. Val('n_sol_excretion', Excretion) * In('yard_days') / 365 * Out(share_excretion_yard);
n_outyard_liquid	kg N /a	Annual N flux form liquid part out of yard. Out('n_into_yard') - Out('nh3_nyard');
n_outyard_solid	kg N /a	Annual N flux from solid part out of yard. 0;
tan_outyard_liquid	kg N /a	Annual N flux as TAN from liquid part out of yard into storage. Out('n_sol_into_yard') - Out('nh3_nyard');
tan_outyard	kg N /a	Annual N flux as TAN out of yard into storage. Out('n_sol_into_yard') - Out('nh3_nyard');
c_floor_properties_exercise_yard	-	Reduction factor for the emission due to the use of the floor properties in housing systems. if (In('floor_properties_exercise_yard') eq 'solid_floor'){ return Tech('red_floor_properties_solid_floor'); } elsif (In('floor_properties_exercise_yard') eq 'unpaved_floor'){ return Tech('red_floor_properties_unpaved_floor'); } elsif (In('floor_properties_exercise_yard')

61.5 Detailed process description

62 Livestock::Pig

Agrammon Group – 2008-02-19

62.1 Short description

Collects the annual emission of NH3 and the N flux for pigs.

62.2 Input parameters

62.3 Technical parameters

62.4 Output

Parameter	Unit	Formula
n_solid_from_pig	kg N /a	Annual N flux from pigs housing, solid fraction. Val(n_outhousing_solid, Pig::Housing);
n_from_pig	kg N /a	Annual N flux from pigs housing. Val(n_outhousing, Pig::Housing);
n_liquid_from_pig	kg N /a	Annual N flux from pigs housing, liquid fraction. Val(n_outhousing_liquid, Pig::Housing);
nh3_npig	kg N /a	Annual NH3 emission from pigs housing and grazing (production). Val(nh3_nhousing, Pig::Housing) + Val(nh3_ngrazing, Pig::Grazing);
tan_from_pig	kg N /a	Annual N flux as TAN from pigs housing. Val(tan_outhousing, Pig::Housing);
tan_liquid_from_pig	kg N /a	Annual N flux as TAN from pigs housing, liquid fraction. Val(tan_outhousing_liquid, Pig::Housing);
tan_solid_from_pig	kg N /a	Annual N flux as TAN from pigs housing, liquid fraction. Val(tan_outhousing_solid, Pig::Housing);
n_excretion	kg N /a	Annual N excreted by pigs. Val(n_excretion, Pig::Excretion);

62.5 Detailed process description

This process summarizes the annual emission of NH3 for pigs from housing and grazing. And it summarizes the annual N flux from housing to the storage for pigs.

63 Livestock::Pig::Excretion

Agrammon Group – 2008-04-22

63.1 Short description

Computes the annual N excretion of diffrent pig categories as a function of the crude protein and the energy content of the feed ration.

63.2 Input parameters

Parameter	Unit	Description
animalcategory	-	Pig category (nursing sows, dry sows, gilts, weaned piglets (up to 25kg), and boars). Possible values: `boars`, `dry_sows`, `gilts`, `nursing_sows`, `weaned_piglets_up_to_25kg`
pigs	-	Number of pigs for the selected type in barn.
crude_protein	g /kg	Crude protein content of feed ration.
energy_content	MJ VES /kg	Energy content of feed ration.

63.3 Technical parameters

Parameter	Value	Unit	Description
standard_N_excretion-_nursing_sows	42	kg N /a	Annual standard N excretion for animal category (nursing sows) according to Flisch et al. (2009).
standard_N_excretion_dry-_sows	20	kg N /a	Annual standard N excretion for animal category (dry sows) according to Flisch et al. (2009).
standard_N_excretion_gilts	13	kg N /a	Annual standard N excretion for animal category (gilts) according to Flisch et al. (2009).
standard_N_excretion-_weaned_piglets_up_to_25kg	4.6	kg N /a	Annual standard N excretion for animal category (piglets) according to Flisch et al. (2009).
standard_N_excretion_boars	18	kg N /a	Annual standard N excretion for animal category (boars) according to Flisch et al. (2009).
standard_crude_protein-_nursing_sows	165	g CP /kg	Standard crude protein content of a feed ration for nursing sows (BLW, SRVA, LBL 2003).
standard_crude_protein_dry-_sows	145	g CP /kg	Standard crude protein content of a feed ration for dry sows(BLW, SRVA, LBL 2003).
standard_crude_protein_gilts	170	g CP /kg	Standard crude protein content of a feed ration for gilts (BLW, SRVA, LBL 2003).
standard_crude_protein-_weaned_piglets_up_to_25kg	175	g CP /kg	Standard crude protein content of a feed ration for piglets (BLW, SRVA, LBL 2003).
standard_crude_protein_boars	145	g CP /kg	Standard crude protein content of a feed ration for boars (BLW, SRVA, LBL 2003).
standard_energy_content-_nursing_sows	12.5	MJ VES	Standard energy content of a feed ration for nursing sows (BLW, SRVA, LBL 2003).
standard_energy_content_dry-_sows	12.5	MJ VES	Standard energy content of a feed ration for dry sows (BLW, SRVA, LBL 2003).
standard_energy_content_gilts	13.5	MJ VES	Standard energy content of a feed ration for gilts (BLW, SRVA, LBL 2003).
standard_energy_content-_weaned_piglets_up_to_25kg	13.5	MJ VES	Standard energy content of a feed ration for piglets (BLW, SRVA, LBL 2003).

standard_energy_content-_boars	12.5	MJ VES	Standard energy content of a feed ration for boars (BLW, SRVA, LBL 2003).
cfeed_nursing_sows	0.007	-	Correction factor for feed with reduced crude protein content for nursing sows (BLW, SRVA, LBL 2003).
cfeed_dry_sows	0.008	-	Correction factor for feed with reduced crude protein content for dry sows (BLW, SRVA, LBL 2003).
cfeed_gilts	0.0054	-	Correction factor for feed with reduced crude protein content for gilts (BLW, SRVA, LBL 2003).
cfeed_weaned_piglets_up_to-_25kg	0.0072	-	Correction factor for feed with reduced crude protein content for piglets (BLW, SRVA, LBL 2003).
cfeed_boars	0.0052	-	Correction factor for feed with reduced crude protein content for boars (BLW, SRVA, LBL 2003).
minimal_N_excretion_nursing-_sows	35.3	kg N /a	Annual minimal N excretion for pig category (nursing sows) according to Flisch et al. (2009).
minimal_N_excretion_dry-_sows	17.5	kg N /a	Annual minimal N excretion for pig category (dry sows) according to Flisch et al. (2009).
minimal_N_excretion_gilts	10.9	kg N /a	Annual minimal N excretion for pig category (gilts) according to Flisch et al. (2009).
minimal_N_excretion_weaned-_piglets_up_to_25kg	3.8	kg N /a	Annual minimal N excretion for pig category (piglets) according to Flisch et al. (2009).
minimal_N_excretion_boars	15.5	kg N /a	Annual minimal N excretion for pig category (boars) according to Flisch et al. (2009).
share_Nsol	0.7	-	Nsol content of excreta from pigs. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).

63.4 Output

Parameter	Unit	Formula
n_sol_excretion	kg N /a	Annual soluble N excreted by a specified number fo pigs. `Tech(share_Nsol) * Out(n_excretion);`
minimal_N_excretion	kg N /a	Minimal annual N excretion for specified pig category according to Flisch et al. (2009). `my $key = "minimal_N_excretion_" . In('animalcategory'); return Tech($key);`
cfeed	-	Correction factor for feed with reduced crude protein content (BLW, SRVA, LBL 2003). `my $key = "cfeed_" . In('animalcategory'); return Tech($key);`
standard_crude_protein	g CP /kg	Annual standard N excretion for specified pig category according to Flisch et al. (2009). `my $key = "standard_crude_protein_" . In('animalcategory'); return Tech($key);`
pigs	-	Number of pigs of a specific category. `In(pigs);`
standard_N_excretion	kg N /a	Annual standard N excretion for specified animal category according to Flisch et al. (2009). `my $key = "standard_N_excretion_" . In('animalcategory'); return Tech($key);`
n_excretion	kg N /a	Annual total N excreted by a specified number of animals. `if( In('energy_content') != 0 ){ Out(standard_N_excretion) * (1 - (Out(standard_crude_protein) - In('crude_protein')) * Out(cfeed)) * ( Out(standard_energy_content) / In('energy_content')) * In(pigs); } else { print STDERR "Energy Content can not be 0, use default value!" };`
standard_energy_content	MJ VES	Standard energy content of the feed ration for selected pig category. `my $key = "standard_energy_content_" . In('animalcategory'); return Tech($key);`

63.5 Detailed process description

This process calculates the annual N excretion (total N and Nsol) of different pig categories according to the crude protein and energy content of the feed ration.

63.5.1 References:

BLW, SRVA, LBL 2003. Weisungen zur Beruecksichtigung von Ökofuttern in der Suisse-Bilanz. 2003.

Burgos SA, Robinson PH, Fadel JG, DePeters EJ 2005. Ammonia volatilization potential: Prediction of urinary urea nitrogen output on lactating dairy cows. Agriculture, Ecosystems and Environment 111:261-269.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

Flisch R, Sinaj S, Charles R, Richner W 2009. Grundlagen für die die Düngung im Acker- und Futterbau. Agrarforschung 16(2).

64 Livestock::Pig::Grazing

Agrammon Group – 2008-02-29

64.1 Short description

Computes the annual NH3 emission from grazing pigs.

64.2 Input parameters

64.3 Technical parameters

Parameter	Value	Unit	Description
er_pig_grazing	0.2	-	Emission rate for the calculation of the annual NH3 emission during grazing for pigs. Sommer et al. (2001) give a yearly volatilization loss from one sow with piglets of 4.8 kg N resulting in a loss of 20% TAN assuming an N excretion/sow/y of 35 kg N (Flisch et al. (2009)).

64.4 Output

Parameter	Unit	Formula
nh3_ngrazing	kg N /a	Annual NH3 emission from all pigs from grazing. Out(n_sol_into_grazing) * Tech(er_pig_grazing);
share_grazing	-	Share of N excretion during outdoor activities for a defined animal category. If pig housing type is 'Outdoor' 100% is assumed. if(Val('housing_type', 'Housing::Type') eq 'Outdoor'){ return 1; }else { return 0; # no correction };
n_into_grazing	kg N /a	Annual N excretion during grazing for pigs. Val('n_excretion', 'Excretion') * Out(share_grazing);
n_remain_pasture	kg N /a	Annual N input on pastures. Out(n_into_grazing) - Out(nh3_ngrazing);
n_sol_into_grazing	kg N /a	Annual soluble N (TAN) excretion during grazing for pigs. Val('n_sol_excretion', 'Excretion') * Out(share_grazing);

64.5 Detailed process description

This process calculates the annual NH3 emission from grazing pigs based on the N excreted on the pastures. The N excreted is calculated according to the time the animals spend on the pasture. It assumes that the excretions on the pasture are proportional to the time the animals are grazed.

64.5.1 References:

Bussink DW 1992. Ammonia volatilization from grassland receiving nitrogen fertilizer and rotationally grazed by dairy cattle. Fertilizer Research 33:257-265.

Bussink DW 1994. Relationship between ammonia volatilization and nitrogen fertilizer application rate, intake and excretion of herbage nitrogen by cattle on grazed swards. Fertilizer Research 38:111-121.

Jarvis SC, Hatch DJ, Lockyer DR 1989. Ammonia fluxes from grazed grassland: annual losses from cattle production systems and their relation to nitrogen inputs. Journal of Agricultural Science 113:99-108.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

Ross CA, Jarvis SC 2001. Measurement of emission and deposition pattern of ammonia from urine in grass swards. Atmospheric environment 35:867-875.

Sommer SG, Sogaard HT, Moller HB, Morsing S 2001. Ammonia volatilization from sows on grassland. Atmospheric environment 35:2023-2032.

Flisch R, Sinaj S, Charles R, Richner W 2009. Grundlagen für die die Düngung im Acker- und Futterbau. Agrarforschung 16(2).

65 Livestock::Pig::Housing

Agrammon Group – 2009-02-22

65.1 Short description

Computes the annual NH3 emission from pig housing systems.

65.2 Input parameters

65.3 Technical parameters

65.4 Output

Parameter	Unit	Formula
tan_outhousing_liquid	kg N /a	Annual N flux as TAN out of housing, slurry or liquid fraction from pigs. if(Val(housing_type, Housing::Type) eq 'Outdoor'){ 0 }else { Out(n_outhousing) * Val('share_liquid', 'Housing::Type') * Out(share_tan_out) };
n_outhousing_liquid	kg N /a	Annual N flux out of housing, slurry or liquid fraction from pigs. if(Val(housing_type, Housing::Type) eq 'Outdoor'){ 0 }else { Out(n_outhousing) * Val('share_liquid', 'Housing::Type') };
n_outhousing	kg N /a	Annual N flux out of the housing. if(Val('housing_type', 'Housing::Type') eq 'Outdoor'){ 0 }else { Out(n_into_housing) - Out(nh3_nhousing) };
n_into_housing	kg N /a	Annual N flux into the house. Val('n_excretion', 'Excretion') - Val('n_into_grazing', 'Grazing');
tan_outhousing	kg N /a	Annual N flux as TAN out of the housing. if(Val(housing_type, Housing::Type) eq 'Outdoor'){ 0 }else { Out(n_sol_into_housing) - Out(nh3_nhousing) };
nh3_nhousing	kg N /a	Annual NH3 emission from pig housing systems. per animal place. Val('n_sol_excretion', 'Excretion') * Val('er_housing', 'Housing::Type') * Val('c_air_scrubber', 'Housing::AirScrubber') * (1 - Val('c_UNECE_housing_task', 'Housing::UNECEhousingTask'));
n_sol_into_housing	kg N /a	Annual N flux as TAN into the house. Val('n_sol_excretion', 'Excretion') - Val('n_sol_into_grazing', 'Grazing');
tan_outhousing_solid	kg N /a	Annual N flux as TAN out of housing, manure fraction of N flux from pigs. if(Val(housing_type, Housing::Type) eq 'Outdoor'){ 0 }else { Out(n_outhousing) * (1 - Val('share_liquid', 'Housing::Type')) * Out(share_tan_out) };
n_outhousing_solid	kg N /a	Annual N flux out of housing, manure fraction of N flux from pigs. if(Val('housing_type', 'Housing::Type') eq 'Outdoor'){ 0 }else { Out(n_outhousing) * (1 - Val('share_liquid', 'Housing::Type')) };
share_tan_out	-	Share of TAN for interface to storage, the same share is assumed for solid and liquid parts of output. Mineralization and immobilization are considerd in the storage module. if(Out(n_outhousing) != 0){ Out(tan_outhousing) / Out(n_outhousing) }else{0};

65.5 Detailed process description

This process calculates the NH3 emission in pig housing depending on the N excretion and the housing systems. The NH3 emission is assumed to be proportional to the total N excretion of the animals because the contaminated surfaces will primarily drive emissions, which will remain active even when animals are on the pasture or exercise yard.

A proportional correction is applied according to the area per animal.

A correction is applied if the part of the day grazing is above a defined grazing hours per days.

65.5.1 Definition of System boundaries for the housing Process:

For housing systems with integrated exercise yards, it is difficult to distinguish between emissions from housing, exercise yard and storage. For these housingtypes the emission may be only validated for the sum of housing, exercise yard and storage emission.

66 Livestock::Pig::Housing::AirScrubber

Agrammon Group – 2008-03-30

66.1 Short description

Computes the annual NH3 reduction due to an air exhaust scrubber in housing systems.

66.2 Input parameters

Parameter	Unit	Description
air_scrubber	-	Air exhaust scrubber (none, acid, biotrickling_filter). Possible values: `acid`, `biotrickling`, `none`

66.3 Technical parameters

Parameter	Value	Unit	Description
red_acid_air_scrubber	0.9	-	Reduction efficiency as compared to group-housed on fully and partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_biotrickling_filter_air-_scrubber	0.7	-	Reduction efficiency as compared to group-housed on fully and partly slatted floors (UNECE 2007, paragraph 71, table 5).

66.4 Output

Parameter	Unit	Formula

c_air_scrubber	-	Reduction factor for the emission due to the use of an air exhaust scrubber in housing systems.
		if (In('air_scrubber') eq 'acid'){ return (1 - Tech('red_acid_air_scrubber'));
		} elsif(In('air_scrubber') eq 'biotrickling'){ return (1 - Tech('red_biotrickling_filter_air_scrubber'));
		} elsif(In('air_scrubber') eq 'none'){ return 1;
		} else{ print STDERR "Invalid 'air_scrubber' defined!";
		return 1;
		}

66.5 Detailed process description

This submodul calculates the annual NH3 reduction due to an air exhaust scrubber in housing systems according to the UNECE guideline 2007.

66.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. ECE/EB.AIR/WG.5/2007/13.

67 Livestock::Pig::Housing::Type

Agrammon Group – 2008-02-19

67.1 Short description

Selects the emission rate and other correciton factors for the specific housing types for pigs.

67.2 Input parameters

Parameter	Unit	Description
housing_type	-	Type of housing. Possible values: `Deep_Litter`, `Outdoor`, `Slurry_Label`, `Slurry_Conventional`

67.3 Technical parameters

67.4 Output

Parameter	Unit	Formula
housing_type	-	Housing type (needed in other modules). In(housing_type);
share_liquid	-	Liquid share for the housing type. Val(share_liquid, 'Type::' . In(housing_type));
er_housing	-	Emission rate for the housing type. Val(er_housing, 'Type::' . In(housing_type));
share_solid	-	Solid share for the housing type. Val(share_solid, 'Type::' . In(housing_type));

67.5 Detailed process description

This process selects the correction factor for the specific housing types for pigs. Among these correction factors are the emission rate for the housing type, the correction factor for the housing type area, the correction factor for the area per animal, the liquid and solid share for the housing type as well as the factor on what barn size increases the regularized minimal (limited to 0.5).

68 Livestock::Pig::Housing::Type::Deep_Litter

Agrammon Group – 2008-04-18

68.1 Short description

Describes correction factors for the label deep litter pig housing system.

68.2 Input parameters

68.3 Technical parameters

Parameter	Value	Unit	Description
er	0.157	-	Emission rate for the label deep litter pig housing system. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 12.81 % Ntot; converted using Nsol of 70%: EF 18.3 % TAN
share_liquid	0	-	For the label deep litter pig housing system 100% of the manure goes into solid manure storage/application.

68.4 Output

Parameter	Unit	Formula
share_liquid	-	Liquid part of Ntot for selected housing type. Tech(share_liquid);
er_housing	-	Emission rate for specific housing type. Tech(er);
share_solid	-	Solid part of Ntot for selected housing type. 1-Tech(share_liquid);

68.5 Detailed process description

This process describes the correction factors for the label deep litter pig housing system such as the housing specific emission rate, the liquid share and solid share.

69 Livestock::Pig::Housing::Type::Outdoor

Agrammon Group – 2008-04-18

69.1 Short description

Describes emission rates for outdoor pigs. Outodoor pigs do not have any housing emissions.

69.2 Input parameters

69.3 Technical parameters

Parameter	Value	Unit	Description
er	0	-	Emission rate for outdoor pigs (equal to zero because all emissions are listed under grazing).
share_liquid	0	-	For the outdoor pigs 0% of the manure goes into the liquid fraction for storage/application.

69.4 Output

Parameter	Unit	Formula
share_liquid	-	Liquid part of Ntot for selected housing type. Tech(share_liquid);
er_housing	-	Emission rate for specific housing type. Tech(er);
share_solid	-	For the outdoor pigs 0% of the manure goes into the solid fraction for storage/application. 0

69.5 Detailed process description

This process describes the correction factors for outdoor pigs such as the housing specific emission rate, the liquid share and solid share. Outodoor pigs do not have any housing emissions, as everything is excreted on pasture.

70 Livestock::Pig::Housing::Type::Slurry_Conventional

Agrammon Group – 2008-04-18

70.1 Short description

Describes correction factors for the conventional slurry pig housing system.

70.2 Input parameters

70.3 Technical parameters

Parameter	Value	Unit	Description
er	0.243	-	Emission rate for the conventional slurry pig housing system. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 17 % Ntot; converted using Nsol of 70%: EF 24.3 % TAN.
share_liquid	1	-	For the conventional slurry pig housing system 100% of the manure goes into the liquid fraction for storage/application.

70.4 Output

Parameter	Unit	Formula
share_liquid	-	Liquid part of Ntot for selected housing type. Tech(share_liquid);
er_housing	-	Emission rate for specific housing type. Tech(er);
share_solid	-	Solid part of Ntot for selected housing type. 1-Tech(share_liquid);

70.5 Detailed process description

This process describes the correction factors for the conventional slurry pig housing system such as the housing specific emission rate, the liquid share and solid share.

71 Livestock::Pig::Housing::Type::Slurry_Label

Agrammon Group – 2008-04-18

71.1 Short description

Describes correction factors for the label slurry pig housing system.

71.2 Input parameters

71.3 Technical parameters

Parameter	Value	Unit	Description
er	0.486	-	Emission rate for the label slurry pig housing system. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 34 % Ntot; converted using Nsol of 70%: EF 48.6 % TAN.
share_liquid	1	-	For the label slurry pig housing system 100% of the manure goes into the liquid fraction for storage/application.

71.4 Output

Parameter	Unit	Formula
share_liquid	-	Liquid part of Ntot for selected housing type. Tech(share_liquid);
er_housing	-	Emission rate for specific housing type. Tech(er);
share_solid	-	Solid part of Ntot for selected housing type. 1-Tech(share_liquid);

71.5 Detailed process description

This process describes the correction factors for the label slurry pig housing system such as the housing specific emission rate, the liquid share and solid share.

72 Livestock::Pig::Housing::UNECEhousingTask

Agrammon Group – 2008-03-30

72.1 Short description

Computes the annual NH3 reduction due to an exhaust air scrubber in housing systems.

72.2 Input parameters

Parameter	Unit	Description
UNECE_category_1-_mitigation_options_for-_housing_systems_for_pigs	-	UNECE housing tasks for partly slatted floor: with scraper (concrete_slats), with flush channels(no areation), with flush channels(areation), with flush gutters/tubes (no areation), with flush gutters/tubes (areation), with channels slanted walls(concrete slats), with channel slanted walls (metal slats), with scraper (metal slats). Possible values: `with_channel_slanted_walls_metal_slats`, `with_channels_slanted_walls_concrete_slats`, `with_flush_channels_areation`, `with_flush_channels_no_areation`, `with_flush_gutters_tubes_areation`, `with_flush_gutters_tubes_no_areation`, `with_scraper_concrete_slats`, `with_scraper_metal_slats`, `none`

72.3 Technical parameters

Parameter	Value	Unit	Description
red_PSF_with_scraper-_concrete_slats	0.4	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush-_channels_no_areation	0.5	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush-_channels_areation	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush_gutters-_tubes_no_areation	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush_gutters-_tubes_areation	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_channels-_slanted_walls_concrete_slats	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_channel-_slanted_walls_metal_slats	0.65	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_with_scraper-_metal_slats	0.5	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).

72.4 Output

Parameter	Unit	Formula
c_UNECE_housing_task	-	Reduction factor for the emission due to UNECE housing systems tasks for fully and partly slatted floors. if (In('UNECE_category_1_mitigation_options_for_housing_systems_for_pigs') eq "with_scraper_concrete_slats"){ return Tech('red_PSF_with_scraper_concrete_slats'); } elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_pigs') eq "with_flush_channels_no_areation"){ return Tech('red_PSF_with_flush_channels_no_areation'); } elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_pigs') eq "with_flush_channels_areation"){ return Tech('red_PSF_with_flush_channels_areation'); } elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_pigs') eq "with_flush_gutters_tubes_no_areation"){ return Tech('red_PSF_with_flush_gutters_tubes_no_areation'); } elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_pigs') eq "with_flush_gutters_tubes_areation"){ return Tech('red_PSF_with_flush_gutters_tubes_areation'); } elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_pigs') eq "with_channels_slanted_walls_concrete_slats"){ return Tech('red_PSF_with_channels_slanted_walls_concrete_slats'); } elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_pigs') eq "with_channel_slanted_walls_metal_slats"){ return Tech('red_PSF_with_channel_slanted_walls_metal_slats'); } elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_pigs') eq "with_scraper_metal_slats"){ return Tech('red_PSF_with_with_scraper_metal_slats'); } elsif(In('UNECE_category_1_mitigation_options_for_housing_systems_for_pigs') eq "none"){ return 0; };

72.5 Detailed process description

This submodul calculates the annual NH3 reduction due to an exhaust air scrubber in housing systems according to the UNECE guideline 2007.

72.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. ECE/EB.AIR/WG.5/2007/13.

73 Livestock::Poultry

Agrammon Group – 2008-02-22

73.1 Short description

Collects the emission of NH3, the N excretion, and the N flux for the diffrent poultry categories per year.

73.2 Input parameters

73.3 Technical parameters

73.4 Output

Parameter	Unit	Formula

n_from_poultry_turkeys-_broilers	kg N /a	Annual N flux from poultry housing.
		
		if(Val('animalcategory',Poultry::Excretion) eq 'turkeys' || Val('animalcategory',Poultry::Excretion) eq 'broilers') { Val('n_outhousing', Poultry::Housing);
		}else{ return(0);
		};

tan_from_poultry_turkeys-_broilers	kg N /a	Annual N flux from poultry housing.
		
		if(Val('animalcategory', Poultry::Excretion) eq 'turkeys' || Val('animalcategory', Poultry::Excretion) eq 'broilers'){ Val('tan_outhousing', Poultry::Housing);
		}else{ return(0);
		};

tan_from_poultry_layers-_growers_other_poultry	kg N /a	Annual N flux from poultry housing.
		
		if(Val('animalcategory', Poultry::Excretion) eq 'layers' || Val('animalcategory', Poultry::Excretion) eq 'growers' || Val('animalcategory', Poultry::Excretion) eq 'other_poultry'){ Val('tan_outhousing', Poultry::Housing);
		}else{ return(0);
		};

tan_from_poultry	kg N /a	Annual N flux from poultry housing. Val('tan_outhousing', Poultry::Housing);
n_excretion	kg N /a	Annual N excreted by poultry. Val('n_excretion', Poultry::Excretion);
n_from_poultry	kg N /a	Annual N flux from poultry housing. Val('n_outhousing', Poultry::Housing);

n_excretion_turkeys_broilers	kg N /a	Annual N excreted by poultry.
		
		if(Val('animalcategory', Poultry::Excretion) eq 'turkeys' || Val('animalcategory', Poultry::Excretion) eq 'broilers'){ Val('n_excretion', Poultry::Excretion);
		}else{ return(0);
		};

nh3_npoultry_turkeys_broilers	kg N /a	Annual NH3 emission from poultry production (housing and outdoor).
		
		if(Val('animalcategory', Poultry::Excretion) eq 'turkeys' || Val('animalcategory', Poultry::Excretion) eq 'broilers'){ Val(nh3_nhousing, Poultry::Housing) + Val(nh3_nfree_range, Poultry::Outdoor);
		}else{ return(0);
		};

n_excretion_layers_growers-_other_poultry	kg N /a	Annual N excreted by poultry.
		
		if (Val('animalcategory', Poultry::Excretion)eq 'layers' || Val('animalcategory', Poultry::Excretion) eq 'growers' || Val('animalcategory', Poultry::Excretion) eq 'other_poultry'){ Val('n_excretion', Poultry::Excretion);
		}else{ return(0);
		};

n_from_poultry_layers-_growers_other_poultry	kg N /a	Annual N flux from poultry housing.
		
		if(Val('animalcategory', Poultry::Excretion) eq 'layers' || Val('animalcategory', Poultry::Excretion) eq 'growers' || Val('animalcategory', Poultry::Excretion) eq 'other_poultry'){ Val('n_outhousing', Poultry::Housing);
		}else{ return(0);
		};

73.5 Detailed process description

This process summarizes the annual emission of NH3, the annual N excretion, and the annual N flux for different poultry categories from housing and outdoor.

74 Livestock::Poultry::Excretion

Agrammon Group – 2008-02-22

74.1 Short description

Computes the annual N excretion of the different poultry categories.

74.2 Input parameters

Parameter	Unit	Description
animalcategory	-	Poultry category (layers, growers, broilers, turkeys, and other poultry). Possible values: `broilers`, `growers`, `other_poultry`, `turkeys`, `layers`
animals	-	Number of poultry animals for the selected type in barn.

74.3 Technical parameters

Parameter	Value	Unit	Description
standard_N_excretion_layers	0.80	kg N /a	Annual standard N excretion for poultry category (layers) according to Flisch et al. (2009).
standard_N_excretion_growers	0.34	kg N /a	Annual standard N excretion for poultry category (growers) according to Flisch et al. (2009).
standard_N_excretion_broilers	0.45	kg N /a	Annual standard N excretion for poultry category (broilers) according to Flisch et al. (2009).
standard_N_excretion_turkeys	1.4	kg N /a	Annual standard N excretion for poultry category according (turkeys) to Flisch et al. (2009).
standard_N_excretion_other_poultry	0.56	kg N /a	Annual standard N excretion for other poultry category according to Flisch et al. (2009).
share_Nsol_layers	0.6	-	Nsol content of excreta for layers. Derived from e.g. TODO
share_Nsol_growers	0.6	-	Nsol content of excreta for growers. Derived from e.g. TODO
share_Nsol_broilers	0.6	-	Nsol content of excreta for broilers. Derived from e.g. TODO
share_Nsol_turkeys	0.6	-	Nsol content of excreta for turkeys. Derived from e.g. TODO
share_Nsol_other_poultry	0.6	-	Nsol content of excreta for other poultry. Derived from e.g. TODO

74.4 Output

Parameter	Unit	Formula
n_sol_excretion	kg N /a	Annual soluble N excreted by an animalgroup of selected poultry category. Out(share_Nsol) * Out(n_excretion)
animalcategory	-	Poultry category (layers, growers, broilers, turkeys, and other poultry). In('animalcategory');

standard_N_excretion	kg N /a	Annual standard N excretion for specified poultry category according to Flisch et al. (2009).
		
		my $key = "standard_N_excretion_" . In('animalcategory');
		return Tech($key);

animals	-	Number of poultry animals for the selected type in barn. In(animals);
n_excretion	kg N /a	Annual N excreted by a specified number of animals. Out(standard_N_excretion) * In(animals);

share_Nsol	-	Nsol content of excreta for a specific poultry category. Derived from e.g. TODO
		
		my $key = "share_Nsol_" . In('animalcategory');
		return Tech($key);

74.5 Detailed process description

This process calculates the annual N excretion of the different poultry categories. The standard N excretion was taken from the official Swiss fertilizer guidelines. The Nsol content of the excreta is based on e.g. Peterson et al. (1998) or Burgos et al. (2005). These values were compiled on the basis of official feeding recommendations (Flisch et al. (2009)) by H. Menzi.

74.5.1 References:

Burgos SA, Robinson PH, Fadel JG, DePeters EJ 2005. Ammonia volatilization potential: Prediction of urinary urea nitrogen output on lactating dairy cows. Agriculture, Ecosystems and Environment 111:261-269.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

Flisch R, Sinaj S, Charles R, Richner W 2009. Grundlagen für die die Düngung im Acker- und Futterbau. Agrarforschung 16(2).

75 Livestock::Poultry::Housing

Agrammon Group – 2008-02-22

75.1 Short description

Computes the NH3 emission, the N flux into the housing and the N flux out of the house from poultry housing per year.

75.2 Input parameters

75.3 Technical parameters

75.4 Output

Parameter	Unit	Formula
n_outhousing	kg N /a	Annual N flux out of the housing. Out(n_into_housing) - Out(nh3_nhousing);
tan_into_housing	kg N /a	Annual N flux into the housing. Val(n_sol_excretion, Excretion) - Val(tan_excr_free_range, Outdoor);
n_into_housing	kg N /a	Annual N flux into the housing. Val(n_excretion, Excretion) - Val(n_excr_free_range, Outdoor);
tan_outhousing	kg N /a	Annual N flux out of the housing. Out(tan_into_housing) - Out(nh3_nhousing);
nh3_nhousing	kg N /a	Annual NH3 emission from poultry housing systems per animal place. (Val(n_excretion, Excretion) * Val(er_housing, Housing::Type) * Val(c_manure_removal_interval, Housing::Type) * Val(c_drinking_system, Housing::Type) * Val(c_covered_basin, Housing::Type) * Val(c_air_scrubber, Housing::AirScrubber));

75.5 Detailed process description

This process calculates the NH3 emission in poultry housing depending on the N excretion and the housing systems. The NH3 emission is assumed to be proportional to the total N excretion of the animals because the contaminated surfaces will primarily drive emissions, which will remain active even when animals are on the pasture or exercise yard.

A proportional correction is applied according to the area per animal.

A correction is applied if the part of the day grazing is above a defined grazing hours per days.

75.5.1 Definition of System boundaries for the housing Process:

For housing systems with integrated exercise yards, it is difficult to distinguish between emissions from housing, exercise yard and storage. For these housingtypes the emission may be only validated for the sum of housing, exercise yard and storage emission.

76 Livestock::Poultry::Housing::AirScrubber

Agrammon Group – 2008-03-30

76.1 Short description

Computes the annual NH3 reduction due to an exhaust air scrubber in housing systems.

76.2 Input parameters

Parameter	Unit	Description
air_scrubber	-	Exhaust air scrubber: none, acid, biotrickling_filter. Possible values: `acid`, `biotrickling_filter`, `none`

76.3 Technical parameters

Parameter	Value	Unit	Description
red_acid_air_scrubber	0.9	-	Reduction efficiency as compared to group-housed on fully and partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_biotrickling_filter_air-_scrubber	0.7	-	Reduction efficiency as compared to group-housed on fully and partly slatted floors (UNECE 2007, paragraph 71, table 5).

76.4 Output

Parameter	Unit	Formula

c_air_scrubber	-	Reduction factor for the emission due to the use of an air exhaust scrubber in housing systems.
		if (In('air_scrubber') eq 'acid'){ return (1 - Tech('red_acid_air_scrubber'));
		} elsif(In('air_scrubber') eq 'biotrickling_filter'){ return (1 - Tech('red_biotrickling_filter_air_scrubber'));
		} elsif(In('air_scrubber') eq 'none'){ return 1;
		} else{ # TODOD print STDERR "Error not defined";
		return 1;
		}

76.5 Detailed process description

This submodul calculates the annual NH3 reduction due to an exhaust air scrubber in housing systems according to the UNECE guideline 2007.

76.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. ECE/EB.AIR/WG.5/2007/13.

77 Livestock::Poultry::Housing::Type

Agrammon Group – 2008-02-19

77.1 Short description

Selects the emission rate and other correction factors for the specific housing types for poultry.

77.2 Input parameters

Parameter	Unit	Description
housing_type	-	Type of housing. Possible values: `deep_litter`, `deep_pit`, `manure_belt`
manure_removal_interval	-	Manure removal interval by manure belt. Possible values: `3_to_4_times_a_month`, `more_than_4_times_a_month`, `no_manure_belt`, `twice_a_month`, `less_than_twice_a_month`
drinking_system	-	Type of drinking system. Possible values: `bell_drinkers`, `drinking_nipples`
droppings_mist_covered_basin	-	Droppings or mist covered basin. Possible values: `no`, `yes`

77.3 Technical parameters

Parameter	Value	Unit	Description
er_housing_layers_growers-_manure_belt	0.15	-	Emission rate for the poultry housing type, based on EAGER workshop January 2007: 15% of Ntot, converted using 60% Nsol and emission factor of 25%.
er_housing_layers_growers-_deep_pit	0.30	-	Emission rate for the poultry housing type, based on EAGER workshop January 2007, UNECE 2007: 30% of Ntot, converted using 60% Nsol and emission factor of 50%.
er_housing_layers_growers-_deep_litter	0.30	-	Emission rate for the poultry housing type, based on EAGER workshop January 2007, UNECE 2007: 30% of Ntot, converted using 60% Nsol and emission factor of 50%.
er_housing_other_deep_litter	0.12	-	Emission rate for the poultry housing type, based on Reidy et al. (2009): 12% of Ntot, converted using 60% Nsol and emission factor of 20%.
c_manure_removal_interval-_less_than_twice_a_month TODO: Give better description!	1.2	-	Emission rate for the poultry manure removal by droppings belt. Empirical assumption by Reidy/Menzi.
c_manure_removal_interval-_twice_a_month TODO: Give better description!	1	-	Emission rate for the poultry manure removal by droppings belt. Empirical assumption by Reidy/Menzi.
c_manure_removal_interval-_3_to_4_times_a_month	0.8	-	Emission rate for the poultry manure removal by droppings belt. Empirical assumption by Reidy/Menzi.

TODO: Give better description!			
c_manure_removal_interval-_more_than_4_times_a-_month TODO: Give better description!	0.6	-	Emission rate for the poultry manure removal by droppings belt. Empirical assumption by Reidy/Menzi.
c_drinking_nipples	1.0	-	Emission rate for the poultry drinking type standard version.
c_bell_drinkers TODO: Give better description!	1.2	-	Emission rate for the poultry drinking type additional emission. Empirical assumption by Reidy/Menzi.
c_droppings_mist_covered-_basin	0.6	-	Emission rate for the droppings or mist covered basin for poultry.

77.4 Output

Parameter	Unit	Formula
housing_type	-	Housing type (needed in other modules). In('housing_type');

c_covered_basin	-	Correction factor for poultry drinking station.
		
		if (In('droppings_mist_covered_basin') eq "yes"){ return Tech('c_droppings_mist_covered_basin');
		} elsif(In('droppings_mist_covered_basin') eq "no"){ return 1.0;
		}else { print STDERR "Invalid 'droppings_mist_covered_basin' defined!";
		return 1.0;
		}

er_housing	-	Emission rate for the poultry housing type.
		
		if (Val('animalcategory', '..::Excretion') eq "layers"){ if (In('housing_type') eq "manure_belt"){ return Tech('er_housing_layers_growers_manure_belt');
		} elsif(In('housing_type') eq "deep_pit"){ return Tech('er_housing_layers_growers_deep_pit');
		} elsif(In('housing_type') eq "deep_litter"){ return Tech('er_housing_layers_growers_deep_litter');
		} } elsif (Val('animalcategory', '..::Excretion') eq "growers"){ if (In('housing_type') eq "manure_belt"){ return Tech('er_housing_layers_growers_manure_belt');
		} elsif(In('housing_type') eq "deep_pit"){ return Tech('er_housing_layers_growers_deep_pit');
		} elsif(In('housing_type') eq "deep_litter"){ return Tech('er_housing_layers_growers_deep_litter');
		} } elsif (Val('animalcategory', '..::Excretion') eq "broilers"){ if (In('housing_type') eq "manure_belt"){ print STDERR "manure_belt not valid, please select deep_litter as housing type for broilers.";
		return Tech('er_housing_other_deep_litter');
		} elsif(In('housing_type') eq "deep_pit"){ print STDERR "deep_pit not valid, please select deep_litter as housing type for broilers.";
		return Tech('er_housing_other_deep_litter');
		} elsif(In('housing_type') eq "deep_litter"){ return Tech('er_housing_other_deep_litter');
		} } elsif (Val('animalcategory', '..::Excretion') eq "turkeys"){ if (In('housing_type') eq "manure_belt"){ print STDERR "manure_belt not valid, please select deep_litter as housing type for turkeys.";
		return Tech('er_housing_other_deep_litter');
		} elsif(In('housing_type') eq "deep_pit"){ print STDERR "deep_pit not valid, please select deep_litter as housing type for turkeys.";
		return Tech('er_housing_other_deep_litter');
		} elsif(In('housing_type') eq "deep_litter"){ return Tech('er_housing_other_deep_litter');
		}else { print STDERR "Invalid 'manure_removal_interval' defined!";
		return 0;
		} } elsif (Val('animalcategory', '..::Excretion') eq "other_poultry"){ if (In('housing_type') eq "manure_belt"){ print STDERR "manure_belt not valid, please select deep_litter as housing type for other_poultry.";
		return Tech('er_housing_other_deep_litter');
		} elsif(In('housing_type') eq "deep_pit"){ print STDERR "deep_pit not valid, please select deep_litter as housing type for other_poultry.";
		return Tech('er_housing_other_deep_litter');
		} elsif(In('housing_type') eq "deep_litter"){ return Tech('er_housing_other_deep_litter');
		}else { print STDERR "Invalid 'manure_removal_interval' defined!";
		return 0;
		} }

drinking_system	-	Drinking system. In('drinking_system');
c_manure_removal_interval	-	Emission rate for the poultry housing type. if (In('manure_removal_interval') eq "less_than_twice_a_month"){ return Tech('c_manure_removal_interval_less_than_twice_a_month'); } elsif(In('manure_removal_interval') eq "twice_a_month"){ return Tech('c_manure_removal_interval_twice_a_month'); } elsif(In('manure_removal_interval') eq "3_to_4_times_a_month"){ return

77.5 Detailed process description

This process selects the emission rate for the specific housing types for poultry and the correction factors for the drinking system, and for the manure removal interval.

77.5.1 References

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. ECE/EB.AIR/WG.5/2007/13. Reidy B, Webb J, Misselbrook TH, Menzi H, Luesink HH, Hutchings NJ, Eurich-Menden B, Döhler H, Dämmgen U 2009. Comparison of models used for national agricultural ammonia emission inventories in Europe: litter-based manure systems. Atmospheric Environment 40, 1632-1640.

78 Livestock::Poultry::Outdoor

Agrammon Group – 2008-02-22

78.1 Short description

Computes the NH3 emission, the N excretion and the remaining N of free range poultry per year.

78.2 Input parameters

Parameter	Unit	Description
free_range	-	Average free range hours per day. Possible values: `no`, `yes`

78.3 Technical parameters

Parameter	Value	Unit	Description
er_free_range	0.7	-	Emission rate for free range poultry, based on Menzi et al. (1997): 70% of TAN or 28% of Ntot
free_range_days_layers	280	d /a	Average free range days per year.
free_range_hours_layers	2.88	h /d	Average free range hours per day, assumed is 12% of Day
free_range_days_growers	280	d /a	Average free range days per year.
free_range_hours_growers	2.88	h /d	Average free range hours per day, assumed is 12% of Day
free_range_days_turkeys	280	d /a	Average free range days per year.
free_range_hours_turkeys	2.88	h /d	Average free range hours per day, assumed is 12% of Day
free_range_days_other-_poultry	280	d /a	Average free range days per year.
free_range_hours_other-_poultry	2.88	h /d	Average free range hours per day, assumed is 12% of Day
free_range_days_broilers	280	d /a	Average free range days per year.
free_range_hours_broilers	0.96	h /d	Average free range hours per day, assumed is 4% of Day

78.4 Output

Parameter	Unit	Formula
n_remain_free_range	kg N /a	Annual N remaining free_range (on pasture, etc.). Out(n_excr_free_range) - Out(nh3_nfree_range);

free_range_hours	h /d	Average free range hours per day.
		
		if(In('free_range') eq 'yes'){ my $key = "free_range_hours_" . Val('animalcategory', 'Excretion');
		return Tech($key);
		}else{ return 0;
		}

nh3_nfree_range	kg N /a	Annual free_range NH3 emission from poultry (grazing). Out(tan_excr_free_range) * Tech(er_free_range);
n_excr_free_range	kg N /a	Annual N excretion free_range (grazing). Val(n_excretion, Excretion) * ((Out(free_range_days)/365) * (Out(free_range_hours)/24));
tan_excr_free_range	kg N /a	Annual N excretion free_range (grazing). Val(n_sol_excretion, Excretion) * ((Out(free_range_days)/365) * (Out(free_range_hours)/24)) ;

free_range_days	d /a	Average free range days per year.
		
		if(In('free_range') eq 'yes'){ my $key = "free_range_days_" . Val('animalcategory', 'Excretion');
		return Tech($key);
		}else{ return 0;
		}

78.5 Detailed process description

This process calculates the annual NH3 emission of free range poultry depending on the free range N excretion and the emission rate. The annual N excretion calculation is based on the grazing hours per day per year and the free range hours per day per year. The annual remaining N from free range poultry is calculated as the annual N excretion minus the annual NH3 emission.

78.5.1 References:

Menzi H, Shariatmadari H, Meierhans D, Wiedmer H 1997: Nähr- und Schadstoffbelastung von Geflügelausläufen. Agrarforschung 4: 361-364.

79 Livestock::SmallRuminants

Agrammon Group – 2008-02-22

79.1 Short description

Collects the annual emission of NH3 and the N flux for goats, fattening sheep and milksheep.

79.2 Input parameters

79.3 Technical parameters

79.4 Output

Parameter	Unit	Formula
n_from_other	kg N /a	Annual N flux from other animals housing. Val(n_outhousing, SmallRuminants::Housing);
tan_liquid_from_other	kg N /a	Annual N flux as TAN from other animals housing, liquid fraction. Val(tan_outhousing_liquid, SmallRuminants::Housing);
nh3_nother	kg N /a	Annual NH3 emission from other animals housing and grazing. Val(nh3_nhousing, SmallRuminants::Housing) + Val(nh3_ngrazing, SmallRuminants::Grazing);
n_solid_from_other	kg N /a	Annual N flux from other animals housing, solid fraction. Val(n_outhousing_solid, SmallRuminants::Housing);
tan_solid_from_other	kg N /a	Annual N flux as TAN from other animals housing, solid fraction. Val(tan_outhousing_solid, SmallRuminants::Housing);
tan_from_other	kg N /a	Annual N flux as TAN from other animals housing. Val(tan_outhousing, SmallRuminants::Housing);
n_excretion	kg N /a	Annual N excreted by other animals. Val(n_excretion, SmallRuminants::Excretion);
n_liquid_from_other	kg N /a	Annual N flux from other animals housing, liquid fraction. Val(n_outhousing_liquid, SmallRuminants::Housing);

79.5 Detailed process description

Summarizes the annual emission of NH3 for goats, fattening sheep and milksheep from housing, yard and grazing. Summarizes the annual N flux from housing to the storage for goats, fattening sheep and milksheep.

80 Livestock::SmallRuminants::Excretion

Agrammon Group – 2008-02-22

80.1 Short description

Computes the annual N excretion of goats, fattening sheep and milksheep.

80.2 Input parameters

Parameter	Unit	Description
animalcategory	-	Animal category (Fattening sheep, milksheep and goats). Possible values: `goats`, `milksheep`, `fattening_sheep`
animals	-	Number of other animals for the selected type in barn.

80.3 Technical parameters

Parameter	Value	Unit	Description
standard_N_excretion_goats	16	kg N /a	Annual standard N excretion for goats according to Flisch et al. (2009).
standard_N_excretion-_fattening_sheep	15	kg N /a	Annual standard N excretion for fattening sheep according to Flisch et al. (2009).
standard_N_excretion-_milksheep	21	kg N /a	Annual standard N excretion for milksheep according to Flisch et al. (2009).
share_Nsol_goats	0.4	-	Nsol content of excreta from goats. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_fattening_sheep	0.4	-	Nsol content of excreta from fattening sheep. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_milksheep	0.4	-	Nsol content of excreta from milksheep. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).

80.4 Output

Parameter	Unit	Formula
n_sol_excretion	kg N /a	Annual soluble N excreted by a specified number of small ruminants. Out(share_Nsol) * Out(n_excretion);

standard_N_excretion	kg N /a	Annual standard N excretion for specified other animal category according to Flisch et al. (2009).
		my $key = "standard_N_excretion_" . In('animalcategory');
		return Tech($key);

animals	-	Number of small ruminants for the selected type in barn. In(animals);
n_excretion	kg N /a	Annual N excreted by a specified number of small ruminants. Out(standard_N_excretion) * In(animals);

share_Nsol	-	Nsol content of excreta of small ruminants. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
		my $key = "share_Nsol_" . In('animalcategory');
		return Tech($key);

80.5 Detailed process description

This process calculated the annual N excretion of small ruminats. The standard N excretion was taken from the official Swiss fertilizer guidelines. The Nsol content of the excreta is based on e.g. Peterson et al. (1998) or Burgos et al. (2005). These values were compiled on the basis of official feeding recommendations (Flisch et al. 2009) by H. Menzi.

80.5.1 References:

Burgos SA, Robinson PH, Fadel JG, DePeters EJ 2005. Ammonia volatilization potential: Prediction of urinary urea nitrogen output on lactating dairy cows. Agriculture, Ecosystems and Environment 111:261-269.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

Flisch R, Sinaj S, Charles R, Richner W 2009. Grundlagen für die die Düngung im Acker- und Futterbau. Agrarforschung 16(2).

81 Livestock::SmallRuminants::Grazing

Agrammon Group – 2008-02-22

81.1 Short description

Computes the annual NH3 emission from grazing goats, fattening sheep, and milksheep.

81.2 Input parameters

Parameter	Unit	Description
grazing_days	d /a	Average grazing days per year.
grazing_hours	h /d	Average grazing hours per day.

81.3 Technical parameters

Parameter	Value	Unit	Description
er_small_ruminants_grazing	0.05	-	Emission rate for the calculation of the annual NH3 emission during grazing of small ruminants. The emission rate is derived from Bussink et al. (1992, 1994), Jarvis et al. (1989), Peterson et al. (1998) and Ross and Jarvis (2001). (taking into account the generally low fertilization rate of Swiss pastures.)

81.4 Output

Parameter	Unit	Formula
grazing_days	d /a	Grazing days per year. In(grazing_days);
nh3_ngrazing	kg N /a	Annual NH3 emission from small ruminants from grazing. Out(n_into_grazing) * Tech(er_small_ruminants_grazing);
n_into_grazing	kg N /a	Annual N excretion during grazing for small ruminants. Val(n_excretion, Excretion) * In(grazing_days) / 365 * In(grazing_hours) / 24;
n_remain_pasture	kg N /a	Annual N input on pastures. Out(n_into_grazing) - Out(nh3_ngrazing);
n_sol_into_grazing	kg N /a	Annual solable N (TAN) excretion during grazing for small ruminants. Val(n_sol_excretion, Excretion) * In(grazing_days) / 365 * In(grazing_hours) / 24;
grazing_hours	h /d	Grazing hours per day. In(grazing_hours);

81.5 Detailed process description

This process calculates the annual NH3 emission from grazing goats, fattening sheep and milksheep based on the total N excreted on the pastures. The N excreted is calculated according to the time the animals spend on the pasture. It assumes that the excretions on the pasture are proportional to the time the animals are grazed.

81.5.1 References:

Bussink DW 1992. Ammonia volatilization from grassland receiving nitrogen fertilizer and rotationally grazed by dairy cattle. Fertilizer Research 33:257-265.

Bussink DW 1994. Relationship between ammonia volatilization and nitrogen fertilizer application rate, intake and excretion of herbage nitrogen by cattle on grazed swards. Fertilizer Research 38:111-121.

Jarvis SC, Hatch DJ, Lockyer DR 1989. Ammonia fluxes from grazed grassland: annual losses from cattle production systems and their relation to nitrogen inputs. Journal of Agricultural Science 113:99-108.

Peterson SO, Sommer SG, Aaes O, Soegaard K 1998. Ammonia losses from urine and dung of grazing cattle: effect of N intake. Atmospheric environment 32:295-300.

Ross CA, Jarvis SC 2001. Measurement of emission and deposition pattern of ammonia from urine in grass swards. Atmospheric environment 35:867-875.

82 Livestock::SmallRuminants::Housing

Agrammon Group – 2008-02-22

82.1 Short description

Computes the annual NH3 emission from small ruminant housing systems.

82.2 Input parameters

82.3 Technical parameters

Parameter	Value	Unit	Description
er_housing	0.11	-	Emission rate for loose housing with liquid, solid manure system is assumed (for TAN 0.275 and Nsol 40%).

82.4 Output

Parameter	Unit	Formula
tan_outhousing_liquid	kg N /a	Annual N flux as TAN out of housing, slurry or liquid fraction of N flux. 0
n_outhousing_liquid	kg N /a	Annual N flux out of housing, slurry or liquid fraction of N flux. 0
n_outhousing	kg N /a	Annual N flux out of the housing. Out(n_into_housing) - Out(nh3_nhousing);
n_into_housing	kg N /a	Annual N flux into the house. Val(n_excretion, Excretion) - Val(n_into_grazing, Grazing);
tan_outhousing	kg N /a	Annual N flux as TAN out of the housing. Out(n_sol_into_housing) - Out(nh3_nhousing);
nh3_nhousing	kg N /a	Annual NH3 emission from small ruminants housing systems per animal place. Val(n_excretion, Excretion) * Tech(er_housing) * Val(k_grazing, Housing::KGrazing)
n_sol_into_housing	kg N /a	Annual N flux as TAN into the house. Val(n_sol_excretion, Excretion) - Val(n_sol_into_grazing, Grazing);
tan_outhousing_solid	kg N /a	Annual N flux as TAN out of housing, manure fraction of N flux. Out(tan_outhousing);
n_outhousing_solid	kg N /a	Annual N flux out of housing, manure fraction of N flux. Out(n_outhousing);

82.5 Detailed process description

This process calculates the NH3 emission in small ruminants housing depending on the N excretion and the housing systems. The NH3 emission is assumed to be proportional to the total N excretion of the animals because the contaminated surfaces will primarily drive emissions, which will remain active even when animals are on the pasture or exercise yard.

A proportional correction is applied according to the area per animal.

A correction is applied if the part of the day grazing is above a defined grazing hours per days.

82.5.1 Definition of System boundaries for the housing Process:

For housing systems with integrated exercise yards, it is difficult to distinguish between emissions from housing, exercise yard and storage. For these housingtypes the emission may be only validated for the sum of housing, exercise yard and storage emission.

83 Livestock::SmallRuminants::Housing::KGrazing

Agrammon Group – 2008-04-1

83.1 Short description

Computes the correction factor for the reduction of small ruminant housing emission if the number of grazing hours per day does increase a specific limit.

83.2 Input parameters

83.3 Technical parameters

Parameter	Value	Unit	Description
k_grazing_reduction_lw5h	0	-	Reduction of housing emissions to 0% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw12h	0.2	-	Reduction of housing emissions to 20% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw22h	0.5	-	Reduction of housing emissions to 50% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_gt22h	1.0	-	Reduction of housing emissions to 100% due to extensive grazing/alping and milking using a mobile milking parlor. Empirical estimation.

83.4 Output

Parameter	Unit	Formula
k_grazing	-	The correction factor for the reduction of the housing emission depending on the number of grazing hours per day and the grazing days per year. if (Val('grazing_hours', '..::Grazing') < 5){ return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_lw5h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } elsif (Val('grazing_hours', '..::Grazing') < 12.0){ return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_lw12h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } elsif (Val('grazing_hours', '..::Grazing') < 22.0) { return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_lw22h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } elsif (Val('grazing_hours', '..::Grazing') >= 22.0) { return ((365.0-Val('grazing_days', '..::Grazing')) + ((1-Tech(k_grazing_reduction_gt22h))*Val('grazing_days', '..::Grazing'))) / 365.0 ; } else { return 1; # no correction };

83.5 Detailed process description

This process calculates the correction factor for the non proportional change of the housing emission according to the grazing hours per day (Webb et al. 2005). It is based on an empirical estimation of Menzi and Katz (1997). The concept has been lately supported by measurements in the UK (Defra 2002), where reductions comparable to those assumed by Menzi and Katz (1997) were reported.

83.5.1 References:

Department for Environment, Food & Rural Affairs, Defra 2002. Ammonia in the UK. DEFRA Publications, London. Menzi H, Katz PE 1997. A differentiated approach to calculate ammonia emissions from animal husbandry. In: Voermans JAM and Monteny GJ (Eds): "Ammonia and odour emissions from animal production facilities", Proc. International Symposium, Vinkeloord, NL, 6-10 October 1997, 35-42.

Webb J, Misselbrook TH 2005. A mass-flow model of ammonia emissions from UK livestock production. Atmospheric environment 38: 2163-2176.

84 PlantProduction

Agrammon Group – 2008-05-07

84.1 Short description

Computes the annual NH3 emission from plant production.

84.2 Input parameters

84.3 Technical parameters

84.4 Output

Parameter	Unit	Formula
nh3_nplantproduction	kg N /a	Annual NH3 emission from plant production. Val(nh3_nagriculturalarea, PlantProduction::AgriculturalArea) + Val(nh3_nmineralfertiliser, PlantProduction::MineralFertiliser) + Val(nh3_nrecyclingfertiliser, PlantProduction::RecyclingFertiliser)

84.5 Detailed process description

This process summarizes the contribution of the plant production to the total NH3 emission.

84.5.1 Differences to DYNAMO

85 PlantProduction::AgriculturalArea

Agrammon Group – 2008-03-30

85.1 Short description

Computes the annual NH3 emission from agricultural area application.

Attention: simplified model based on total N output from storage!!!

85.2 Input parameters

Parameter	Unit	Description
agricultural_area	ha	Agricultural area.

85.3 Technical parameters

Parameter	Value	Unit	Description
er_agricultural_area	2	kg N /ha /a	Emission rate from the agricultural area. The average rate has been derived from Schjoerring and Mattson (2001). Emission based on kg/ ha AA (AA = agricultural area, Landwirschaftliche NutzflÃ¤che). N ist NH3 N.

85.4 Output

Parameter	Unit	Formula
nh3_nagriculturalarea	kg N /a	NH3 emission from agricultural area. In(agricultural_area) * Tech(er_agricultural_area);

85.5 Detailed process description

This process computes the annual average NH3 emission from agricultural area application. The standard emission factor is corrected according to the TAN content and the application rate, the application technology, the crops to which the manure is applied, respected soft measures during application and the application season, the time lag between application and incorporation, the incorporation technology used, and the proportion of solid manure that is applied on hot days.

85.5.1 References:

Vanderweerden and Jarvis (1997)

86 PlantProduction::MineralFertiliser

Agrammon Group – 2008-03-30

86.1 Short description

Computes the annual NH3 emission from mineral fertiliser application.
Attention: simplified model based on total N output from storage!!!

86.2 Input parameters

Parameter	Unit	Description
mineral_nitrogen_fertiliser-_urea	kg N /a	Amount of urea in kg N /a.
mineral_nitrogen_fertiliser-_except_urea	kg N /a	Amount of nitrogen fertiliser (except urea) in kg N /a.

86.3 Technical parameters

Parameter	Value	Unit	Description
er_App_mineral_nitrogen-_fertiliser_urea	0.15	-	Emission rate for the application of urea. The average rate has been derived from Vanderweerden and Jarvis (1997). Emission based on Ntot.
er_App_mineral_nitrogen-_fertiliser_except_urea	0.02	-	Emission rate for the application of ammonium nitrate. The average rate has been derived from Vanderweerden and Jarvis (1997). Emission based on Ntot.

86.4 Output

Parameter	Unit	Formula
nh3_nmineralfertiliser	kg N /a	NH3 emission from mineral fertiliser application. In(mineral_nitrogen_fertiliser_urea) * Tech(er_App_mineral_nitrogen_fertiliser_urea) + In(mineral_nitrogen_fertiliser_except_urea) * Tech(er_App_mineral_nitrogen_fertiliser_except_urea);

86.5 Detailed process description

This process computes the annual average NH3 emission from mineral fertiliser application. The standard emission factor is corrected according to the TAN content and the application rate, the application technology, the crops to which the manure is applied, respected soft measures during application and the application season, the time lag between application and incorporation, the incorporation technology used, and the proportion of solid manure that is applied on hot days.

86.5.1 References:

Vanderweerden and Jarvis (1997)

87 PlantProduction::RecyclingFertiliser

Agrammon Group – 2008-03-30

87.1 Short description

Computes the annual NH3 emission from recycling fertiliser application.
Attention: simplified model based on total N output from storage!!!

87.2 Input parameters

Parameter	Unit	Description
compost	t /a	Amount of compost (in t fresh matter per year). Kompost besteht aus GrÃ¼nabfÃ¤llen nicht-landwirtschaftlicher Herkunft von gewerblich-industriellen Anlagen oder von Feldrandkompostierung.
solid_digestate	t /a	Amount of solid digestate form industrial factories.
liquid_digestate	m3 /a	Amount of liquid digestate form industrial factories.

87.3 Technical parameters

Parameter	Value	Unit	Description
er_compost 0.3 kg TAN per t fresh matter (Flisch et al., 2009). of TAN.	0.24	kg N / t	Emission rate from compost, calculated with an emmission rate of 80
er_solid_digestate	0.24	kg N / t	Emission rate for solid digestat from industrial plantse, calculated with an emmission rate of 80
er_liquid_digestate	1.2	kg N / t	Emission rate from liquid digestate from industrial plants, calculated with an emmission rate of 60

87.4 Output

Parameter	Unit	Formula
nh3_ncompost	kg N /a	NH3 emission from compost. In(compost) * Tech(er_compost);
nh3_nrecyclingfertiliser	kg N /a	NH3 emission from total recycling fertiliser. In(liquid_digestate) * Tech(er_liquid_digestate) + In(solid_digestate) * Tech(er_solid_digestate) + In(compost) * Tech(er_compost);
nh3_nliquid_degestate	kg N /a	NH3 emission from liquid digestate. In(liquid_digestate) * Tech(er_liquid_digestate);
nh3_nsolid_degestate	kg N /a	NH3 emission from solid digestate. In(solid_digestate) * Tech(er_solid_digestate);

87.5 Detailed process description

This process computes the annual average NH3 emission from recycling fertiliser application. The standard emission factor is corrected according to the TAN content and the application rate, the application technology, the crops to which the manure is applied, respected soft measures during application and the application season, the time lag between application and incorporation, the incorporation technology used, and the proportion of solid manure that is applied on hot days.

87.5.1 References:

Vanderweerden and Jarvis (1997)

88 Storage

Agrammon Group – 2008-02-29

88.1 Short description

Computes the annual NH3 emission from manure storage based on a categorised slurry type and the cover type.

88.2 Input parameters

88.3 Technical parameters

Parameter	Value	Unit	Description
mineralizationrate_liquid	0.1	-	A netto mineralization of 10% from Norg to NSol/TAN is assuemd, according to the GAS_EM Model
immobilizationrate_solid	0.4	-	A netto immobilization of 40% from NSol/TAN to Norg is assuemd, according to the GAS_EM Model
immobilizationrate_poultry	0.4	-	A netto immobilization of 40% from NSol/TAN to Norg is assuemd, according to the GAS_EM Model

88.4 Output

Parameter	Unit	Formula
n_into_application-_poultryManure	kg N /a	Annual N flux out of storage for manure application. Val(n_into_storage_poultry, Livestock) - Val(nh3_npoultry, Storage::SolidManure::Poultry);
n_into_application_manure-_dairycows_cattle_pigs	kg N /a	Annual N flux out of storage for manure application. Val(n_into_storage_solid_dairycows_cattle_pigs, Livestock) - Val(nh3_nsolid_dairycows_cattle_pigs, Storage::SolidManure);
mineralization_liquid	kg N /a	Annual TAN mineralized from not TAN fraction in liquid storage. if(Val(tan_into_storage_liquid, Livestock) < Sum(nh3_nliquid, Storage::Slurry)) {0} else { Tech(mineralizationrate_liquid) * (Val(n_into_storage_liquid, Livestock) - Val(tan_into_storage_liquid, Livestock)) }
n_into_application	kg N /a	Annual N flux out of storage for application. Out(n_into_application_liquid) + Out(n_into_application_manure) + Out(n_into_application_poultryManure);
immobilization_poultry-_turkeys_broilers	kg N /a	Annual TAN immobilized from TAN fraction in poultry manure storage. Tech(immobilizationrate_poultry) * (Val(tan_into_storage_poultry_turkeys_broilers, Livestock) - Val(nh3_npoultry_turkeys_broilers, Storage::SolidManure::Poultry))
tan_into_application-_poultryManure_turkeys-_broilers	kg N /a	Annual N flux as TAN out of storage for manure application. Val(tan_into_storage_poultry_turkeys_broilers, Livestock) - Val(nh3_npoultry_turkeys_broilers, Storage::SolidManure::Poultry) - Out(immobilization_poultry_turkeys_broilers);
n_into_application_manure-_horses_otherequides-_smallruminants	kg N /a	Annual N flux out of storage for manure application. Val(n_into_storage_solid_horses_otherequides_smallruminants, Livestock) - Val(nh3_nsolid_horses_otherequides_smallruminants, Storage::SolidManure);
tan_into_application-_poultryManure_layers-_growers_other_poultry	kg N /a	Annual N flux as TAN out of storage for manure application. Val(tan_into_storage_poultry_layers_growers_other_poultry, Livestock) - Val(nh3_npoultry_layers_growers_other_poultry, Storage::SolidManure::Poultry) - Out(immobilization_poultry_layers_growers_other_poultry);
tan_into_application_manure	kg N /a	Annual N flux as TAN out of storage for manure application. Val(tan_into_storage_solid, Livestock) - Val(nh3_nsolid, Storage::SolidManure) - Out(immobilization_solid);
immobilization_poultry_layers-_growers_other_poultry	kg N /a	Annual TAN immobilized from TAN fraction in poultry manure storage. Tech(immobilizationrate_poultry) * (Val(tan_into_storage_poultry_layers_growers_other_poultry, Livestock) - Val(nh3_npoultry_layers_growers_other_poultry, Storage::SolidManure::Poultry))
tan_into_application_liquid	kg N /a	Annual N flux as TAN out of storage for application. if(Val(tan_into_storage_liquid, Livestock) < Sum(nh3_nliquid, Storage::Slurry)) {0} else {Val(tan_into_storage_liquid, Livestock) - Sum(nh3_nliquid, Storage::Slurry) + Out(mineralization_liquid)};
tan_into_application-_poultryManure	kg N /a	Annual N flux as TAN out of storage for manure application. Val(tan_into_storage_poultry, Livestock) - Val(nh3_npoultry,

88.5 Detailed process description

This process calculates the NH3 emission from slurry storage, considering both slurry from slurry based systems and liquid from liquid/solid systems. The surface to volume ration (measure for the emitting surface), the cover type and artificial slurry aeration are accounted for via correction factors. Calculations are performed independently for slurry and liquid from liquid/solid systems with the same procedure.

88.5.1 References:

De Bode MJC, 1990. Vergleich der Ammoniakemissionen aus verschiedenen Flüssigmistlagersystemen. In: Ammoniak in der Umwelt. Hrsg.: KTBL und VDI, Münster, 34:1-13.

89 Storage::Slurry

Agrammon Group – 2008-05-20

89.1 Short description

Describes a single liquid manuare storage.

89.2 Input parameters

Parameter	Unit	Description
volume	m3	Volume of slurry store.
depth	m	Depth of slurry store.
mixing_frequency	-	Frequency of mixing of slurry store. Possible values: `13_to_20_times_per_year`, `21_to_30_times_per_year`, `3_to_6_times_per_year`, `7_to_12_times_per_year`, `more_than_30_times_per_year`, `1_to_2_times_per_year`

89.3 Technical parameters

Parameter	Value	Unit	Description
c_mixing_1_to_2_times_per-_year	0.9	-	Correction for mixingfrequency in slurry storage. Based on DeBode(1990), Sommer et al.(1993), Menzi et al. (1997a)
c_mixing_3_to_6_times_per-_year	0.95	-	Correction for mixingfrequency in slurry storage. Based on DeBode(1990), Sommer et al.(1993), Menzi et al. (1997a)
c_mixing_7_to_12_times-_per_year	1	-	Correction for mixingfrequency in slurry storage. Default or Basis value
c_mixing_13_to_20_times-_per_year	1.1	-	Correction for mixingfrequency in slurry storage. Empirical Estimation Reidy/Menzi
c_mixing_21_to_30_times-_per_year	1.2	-	Correction for mixingfrequency in slurry storage. Empirical Estimation Reidy/Menzi
c_mixing_more_than_30-_times_per_year	1.3	-	Correction for mixingfrequency in slurry storage.

89.4 Output

Parameter	Unit	Formula

c_mixing	-	Correction factor for number of mixing frequency in storage, accoording to selected levels.
		
		`my $key = "c_mixing_" . In(mixing_frequency);`
		`return Tech($key);`

nh3_nliquid	kg N /a	Annual NH3 emission from slurry storage. `Val(ef_liquid, Slurry::EFLiquid) * Out(surface_area) * Out(c_mixing);`

surface_area	m2	Surface area of slurry storage.
		
		`if(In('depth') <= 0){ return 0;`
		`}else{ return In('volume') / In('depth');`
		`}`

89.5 Detailed process description

This Process calculates the annual NH3 emission from a single liquid manuare storage, considering a specific emission factor.

89.5.1 References

De Bode MJC, 1990. Vergleich der Ammoniakemissionen aus verschiedenen Flüssigmistlagersystemen. In: Ammoniak in der Umwelt. Hrsg.: KTBL und VDI, Münster, 34:1-13. Menzi H, Frick R, Kaufmann R, 1997a. Ammoniak-Emissionen in der Schweiz: Ausmass und technische Beurteilung des Reduktionspotentials. Eidgenössische Forschungsanstalt für Agrarökologie und Landbau, Zürich-Reckenholz. 107pp. Sommer SG, Christensen BT, Nielsen NE, Schjorring JK, 1993. Ammonia volatilization during storage of cattle and pig slurry - effect of surface cover. Journal of Agricultural Science 121:63-71.

90 Storage::Slurry::EFLiquid

Agrammon Group – 2008-04-22

90.1 Short description

Calculates the emission factor for a specific slurry storage.

90.2 Input parameters

Parameter	Unit	Description
cover_type	-	Cover type of liquid storage. Possible values: `floating_cover`, `natural_crust`, `perforated_cover`, `solid_cover`, `tent`, `uncovered`
contains_cattle_manure	-	Describes if the specific storage contains cattle manure. Possible values: `no`, `yes`
contains_pig_manure	-	Describes if the specific storage contains pig manure. Possible values: `no`, `yes`

90.3 Technical parameters

Parameter	Value	Unit	Description
ef_cattle_uncovered	2.19	kg N /m2 /a	The emission factor for uncovered storage is based on experiments of de Bode (1990) and Sommer et al. (1993) measuring emissions of 2.5 to 6.9 g N m-2 day-1 for cattle slurry, for the emission of the none coverd a mean of the higher values is assumed. -> Assumption: 6.0 gN m-2 day-1 resp. 2.19 kg N /m2 /yr according to the results of the decision of the session of 10 April 208 (participants: C. Bonjour, C. Leuenbergern, M. Raaflaub, H. Menzi, T. Kupper).
ef_cattle_solid_cover	0.219	kg N /m2 /a	Emission factor for solid covered storage based on ef_cattle_uncovered with a reduction of 90%. UNECE (2007) p 13 does suggest a reduction of 80%. Since covers of storages are more tight in Switzerland a reduction of 90% was choosen.
ef_cattle_tent	0.876	kg N /m2 /a	Emission factor for tent covered storage (ef_cattle_uncovered with a reduction of 60%) differs to the UNECE (2007) p.13 reference (ef_cattle_uncovered with a reduction of 80% after UNECE (2007))based on mutual agreement of AGRAMMON participants that newer studies showed that tent covered storage emit more ammonia then assumed by UNECE.

ef_cattle_floating_cover	0.438	kg N /m2 /a	Emission factor for floating covered storage (sheeting may be a type of plastic, canvas or other suitable material) (ef_cattle_uncovered with a reduction of 80%) differs to the UNECE (2007) p.13 referrence (ef_cattle_uncovered with a reduction of 60% after UNECE (2007))based on mutual agreement of AGRAMMON participants that newer studies showed that floating covered storage emit less ammonia then assumed by UNECE.
ef_cattle_perforated_cover	1.314	kg N /m2 /a	Emission factor for perforated_cover storage based on ef_cattle_uncovered with a reduction of 40% after UNECE (2007) p 13.
ef_cattle_natural_crust	1.314	kg N /m2 /a	Emission factor for a natural crust covered storage based on ef_cattle_uncovered with a reduction of 40% after UNECE (2007) p 13.
ef_pig_uncovered	2.92	kg N /m2 /a	The Emission factor for uncovered storage is based on experiments of de Bode (1990) and Sommer et al. (1993) measuring emissions of 2.5 to 6.9 g N m-2 day-1 for cattle slurry, for the emission of the none coverd a mean of the higher values is assumed. Assumption: 8.0 gN m-2 day-1 resp. 2.92 kgN m-2 /yr according to the report "AbklÃ¤rungen zur Klasierung von Stallsystemen und HofdÃ¼ngerlagern bezÃ¼glich der Ammoniak-Emissionen" and the decision of the session of 10 April 208 (participants: C. Bonjour, C. Leuenbergern, M. Raaflaub, H. Menzi, T. Kupper).
ef_pig_solid_cover	0.292	kg N /m2 /a	Emission factor for solid coverd storage based on ef_pig_uncovered with a reduction of 90%. UNECE (2007) p 13 does suggest a reduction of 80%.Since covers of storages are more tight in Switzerland a reduction of 90% was choosen.
ef_pig_tent	1.168	kg N /m2 /a	Emission factor for tent covered storage (ef_pig_uncovered with a reduction of 60%) differs to the UNECE (2007) p.13 referrence (ef_pig_uncovered with a reduction of 80% after UNECE (2007))based on mutual agreement of AGRAMMON participants that newer studies showed that tent covered storage emit more ammonia then assumed by UNECE.

ef_pig_floating_cover	0.584	kg N /m2 /a	Emission factor for floating covered storage (sheeting may be a type of plastic, canvas or other suitable material) (ef_pig_uncovered with a reduction of 80%) differs to the UNECE (2007) p.13 referrence (ef_pig_uncovered with a reduction of 60% after UNECE (2007))based on mutual agreement of AGRAMMON participants that newer studies showed that floating covered storage emit less ammonia then assumed by UNECE.
ef_pig_perforated_cover	1.752	kg N /m2 /a	Emission factor for perforated_cover storage based on ef_pig_uncovered with a reduction of 40% after UNECE (2007) p 13.
ef_pig_natural_crust	1.752	kg N /m2 /a	Emission factor for a natural crust covered storage (e.g. chopped straw, peat, bark, LECA balls, ect.)based on ef_pig_uncovered with a reduction of 40% after UNECE (2007) p 13.

90.4 Output

Parameter	Unit	Formula

ef_pigs_liquid	kg N /m2 /a	Emission factor of a specific liquid storage for pig.
		
		my $key = "ef_pig_" . In(cover_type);
		return Tech($key);

ef_liquid	kg N /m2 /a	Emission factor of a specific liquid storage, if storage conatains cattle and pig manure, a maen distribution depending on the n flow into liqud storage is assumed. Which does not consider possible separet storage units.
		
		if(In(contains_cattle_manure) eq 'yes' and In(contains_pig_manure) eq 'no'){ return Out(ef_cattle_liquid);
		} elsif(In(contains_cattle_manure) eq 'no' and In(contains_pig_manure) eq 'yes'){ return Out(ef_pigs_liquid);
		} elsif(In(contains_cattle_manure) eq 'yes' and In(contains_pig_manure) eq 'yes'){ if(Val(n_into_storage_liquid, ::Livestock) != 0){ return (Val(n_into_storage_liquid_pigs, ::Livestock) * Out(ef_pigs_liquid) + (Val(n_into_storage_liquid, ::Livestock) - Val(n_into_storage_liquid_pigs, ::Livestock)) * Out(ef_cattle_liquid)) / Val(n_into_storage_liquid, ::Livestock) }else{ return (Out(ef_cattle_liquid) + Out(ef_pigs_liquid))/2;
		} } else{ # print STDERR "ERROR NO TODO defined yet;
		";
		return 0;
		};

ef_cattle_liquid	kg N /m2 /a	Emission factor of a specific liquid storage for cattle.
		
		my $key = "ef_cattle_" . In(cover_type);
		return Tech($key);

90.5 Detailed process description

90.5.1 References:

UNECE 2007. Guidance document on control techniques for preventing and abating emissions of ammonia. ECE/EB.AIR/WG.5/2007/13.

De Bode MJC, 1990. Vergleich der Ammoniakemissionen aus verschiedenen Flüssigmistlagersystemen. In: Ammoniak in der Umwelt. Hrsg.: KTBL und VDI, Münster, 34:1-13.

Sommer SG, Christensen BT, Nielsen NE, Schjorring JK, 1993. Ammonia volatilization during storage of cattle and pig slurry - effect of surface cover. Journal of Agricultural Science 121:63-71.

91 Storage::SolidManure

Agrammon Group – 2008-04-22

91.1 Short description

Computes the annual NH3 emission from solid manure storages.

91.2 Input parameters

91.3 Technical parameters

91.4 Output

Parameter	Unit	Formula
nh3_nsolid_poultry	kg N /a	Annual NH3 emission from storage of poultry solid manure. Val(nh3_npoultry, SolidManure::Poultry);
nh3_nsolid_horses-_otherequides_smallruminants	kg N /a	Annual NH3 emission from storage of other equides and small ruminants solid manure. Val(nh3_nsolid_horses_otherequides_smallruminants, Solid-Manure::Solid);
nh3_nsolid_dairycows_cattle-_pigs	kg N /a	Annual NH3 emission from storage of dairy cows, cattle and pigs solid manure. Val(nh3_nsolid_dairycows_cattle_pigs, SolidManure::Solid);
tan_into_storage_solid-_dairycows_cattle	kg N /a	Annual NH3 emission from solid storage. Val(tan_into_storage_solid_dairycows_cattle, SolidMa-nure::Solid);
nh3_nsolid	kg N /a	Annual NH3 emission from storage of solid manure. Out(nh3_nsolid_dairycows_cattle_pigs)+ Out(nh3_nsolid_horses_otherequides_smallruminants)+ Out(nh3_nsolid_poultry);
tan_into_storage_solid_pigs	kg N /a	Annual NH3 emission from solid storage. Val(tan_into_storage_solid_pigs, SolidManure::Solid);
n_fromsolid	kg N /a	Annual N flux from solid storage to application. Val(n_into_storage_solid, ::Livestock) - Out(nh3_nsolid);
tan_into_storage_solid-_horses_otherequides-_smallruminants	kg N /a	Annual NH3 emission from solid storage. Val(tan_into_storage_solid_horses_otherequides_smallruminants, SolidManure::Solid);

91.5 Detailed process description

This process calculates the annual NH3 emission from solid manure storage, considering a mean emission rate on TAN flux in solid storage.

92 Storage::SolidManure::Poultry

Agrammon Group – 2008-05-27

92.1 Short description

Computes the annual NH3 emission from poultry manure storages.

92.2 Input parameters

Parameter	Unit	Description
share_applied_direct_poultry-_manure	%	Share of poultry manure applied to land without storage.

92.3 Technical parameters

Parameter	Value	Unit	Description
er_layers_growers_other-_poultry	0.15	-	Emission rate for layers, growers and other poultry for manure (deep pit, deep litter) and droppings (manure belt)(based on EAGER workshop, January 2008: 15% Ntot, converted using Nsol 60% and emission factor of 25%.
er_turkeys_broilers	0.06	-	Emission rate for manure of broilers and turkeys based on EAGER workshop, January 2008: 6% Ntot, converted using Nsol 60% and emission factor of 10%.

92.4 Output

Parameter	Unit	Formula
n_fromPoultry_turkeys-_broilers	kg N /a	Annual N flux from poultry manure storage to application. Val(n_into_storage_poultry_turkeys_broilers, ::Livestock) - Out(nh3_npoultry_turkeys_broilers);
nh3_npoultry_turkeys_broilers	kg N /a	Annual NH3 emission from poultry manure storage. if (In(share_applied_direct_poultry_manure) > 1) { return (Tech(er_turkeys_broilers) * Val(n_into_storage_poultry_turkeys_broilers, ::Livestock) * (1-(In(share_applied_direct_poultry_manure)/100))); } else { return (Tech(er_turkeys_broilers) * Val(n_into_storage_poultry_turkeys_broilers, ::Livestock) * (1-In(share_applied_direct_poultry_manure))); };
n_fromPoultry_layers-_growers_other_poultry	kg N /a	Annual N flux from poultry manure storage to application. Val(n_into_storage_poultry_layers_growers_other_poultry, ::Livestock) - Out(nh3_npoultry_layers_growers_other_poultry);
n_fromPoultry	kg N /a	Annual N flux from poultry manure storage to application. Out(n_fromPoultry_layers_growers_other_poultry) + Out(n_fromPoultry_turkeys_broilers);
nh3_npoultry_layers_growers-_other_poultry	kg N /a	Annual NH3 emission from poultry manure storage. if (In(share_applied_direct_poultry_manure) > 1) { return (Tech(er_layers_growers_other_poultry) * Val(n_into_storage_poultry_layers_growers_other_poultry, ::Livestock) * (1-(In(share_applied_direct_poultry_manure)/100))); } else { return (Tech(er_layers_growers_other_poultry) * Val(n_into_storage_poultry_layers_growers_other_poultry, ::Livestock) * (1-In(share_applied_direct_poultry_manure))); };
nh3_npoultry	kg N /a	Annual NH3 emission from poultry manure storage. Out(nh3_npoultry_layers_growers_other_poultry) + Out(nh3_npoultry_turkeys_broilers);

92.5 Detailed process description

This process calculates the annual NH3 emission from poultry manure storage, considering a mean emission rate on TAN flux in storage.

92.5.1 References:

European Agricultural Gaseous Emissions Inventory Researchers Network - EAGER workshop, January 2008.

93 Storage::SolidManure::Solid

Agrammon Group – 2008-04-22

93.1 Short description

Computes the annual NH3 emission from solid manure storages.

93.2 Input parameters

Parameter	Unit	Description
share_applied_direct_cattle-_other_manure	%	Share of cattle manure applied to land without storage.
share_applied_direct_pig-_manure	%	Share of pig manure applied to land without storage.

93.3 Technical parameters

Parameter	Value	Unit	Description
er_tan_pigs	0.5	-	The value has been derived from the Eager workshop, January 2008: (additional explanation following)
er_tan_cattle_other	0.3	-	The value has been derived from the Eager workshop, January 2008: (additional explanation following)

93.4 Output

Parameter	Unit	Formula
nh3_nsolid_horses-_otherequides_smallruminants	kg N /a	Annual NH3 emission from solid storage. Tech(er_tan_cattle_other) * Out(tan_into_storage_solid_horses_otherequides_smallruminants);
nh3_nsolid_dairycows_cattle-_pigs	kg N /a	Annual NH3 emission from solid storage. Tech(er_tan_cattle_other) * Out(tan_into_storage_solid_dairycows_cattle) + Tech(er_tan_pigs) * Out(tan_into_storage_solid_pigs);
tan_into_storage_solid-_dairycows_cattle	kg N /a	Annual NH3 emission from solid storage. if (In(share_applied_direct_cattle_other_manure) > 1) { return (Val(tan_into_storage_solid_dairycows_cattle, ::Livestock) * (1-(In(share_applied_direct_cattle_other_manure)/100))) } else { return (Val(tan_into_storage_solid_dairycows_cattle, ::Livestock) * (1-In(share_applied_direct_cattle_other_manure))) };
nh3_nsolid	kg N /a	Annual NH3 emission from solid storage. Tech(er_tan_cattle_other) * Out(tan_into_storage_solid_dairycows_cattle) + Tech(er_tan_pigs) * Out(tan_into_storage_solid_pigs) + Tech(er_tan_cattle_other) * Out(tan_into_storage_solid_horses_otherequides_smallruminants);
tan_into_storage_solid_pigs	kg N /a	Annual NH3 emission from solid storage. if (In(share_applied_direct_pig_manure) > 1) { return ((Val(tan_into_storage_solid_pigs, ::Livestock)) * (1-(In(share_applied_direct_pig_manure)/100))) } else { return ((Val(tan_into_storage_solid_pigs, ::Livestock)) * (1-In(share_applied_direct_pig_manure))) };
n_fromsolid	kg N /a	Annual N flux from solid storage to application. Val(n_into_storage_solid, ::Livestock) - Out(nh3_nsolid);
tan_into_storage_solid-_horses_otherequides-_smallruminants	kg N /a	Annual NH3 emission from solid storage. if (In(share_applied_direct_cattle_other_manure) > 1) { return (Val(tan_into_storage_solid_horses_otherequides_smallruminants, ::Livestock) * (1- (In(share_applied_direct_cattle_other_manure)/100))) } else { return (Val(tan_into_storage_solid_horses_otherequides_smallruminants, ::Livestock) * (1-(In(share_applied_direct_cattle_other_manure)))) };

93.5 Detailed process description

This process calculates the annual NH3 emission from solid manure storage, considering a mean emission rate on TAN flux in solid storage.

94 SummaryByAnimalCategory

Agrammon Group – 2009-04-22

94.1 Short description

Collects the annual NH3 emission by Animalcategories

94.2 Input parameters

94.3 Technical parameters

94.4 Output

Parameter	Unit	Formula
nh3_nfatteningpig_storage	kg N /a	Annual NH3 emission from storage (estimation proportional to input of animalcategory in storage) Out(share_storage_fatteningpig) * Val(nh3_nstorage, Storage);
nh3_ndairycow_total	kg N /a	Annual NH3 emission from dairycow (Application and storage, estimation proportional to input of animalcategory in storage) Out(nh3_ndairycow_grazing) + Out(nh3_ndairycow_housing_and_yard) + Out(nh3_ndairycow_storage) + Out(nh3_ndairycow_application);
nh3_notherpig_application	kg N /a	Annual NH3 emission from application (estimation proportional to input of animalcategory in storage) Out(share_storage_otherpig) * Val(nh3_napplication, Application);
n_excretion_otherpig	kg N /a	Total annual N excreted by all other pigs. Sum(n_excretion, Livestock::Pig)
nh3_nsmall_ruminant-_application	kg N /a	Annual NH3 emission from application (estimation proportional to input of animalcategory in storage) Out(share_storage_small_ruminant) * Val(nh3_napplication, Application);
nh3_npig_total	kg N /a	Annual NH3 emission from pig (Application and storage, estimation proportional to input of animalcategory in storage) Out(nh3_npig_grazing) + Out(nh3_npig_housing_and_yard) + Out(nh3_npig_storage) + Out(nh3_npig_application);
nh3_nother_total	kg N /a	Annual NH3 emission from other (Application and storage, estimation proportional to input of animalcategory in storage) Out(nh3_nother_grazing) + Out(nh3_nother_housing_and_yard) + Out(nh3_nother_storage) + Out(nh3_nother_application);
nh3_nfatteningpig_application	kg N /a	Annual NH3 emission from application (estimation proportional to input of animalcategory in storage) Out(share_storage_fatteningpig) * Val(nh3_napplication, Application);
nh3_nother_housing_and-_yard	kg N /a	Annual NH3 emission from equides and small ruminants from all housings and yards. Sum(nh3_nhousing, Livestock::SmallRuminants::Housing) + Sum(nh3_nhousing, Livestock::Equides::Housing) + Sum(nh3_nyard, Livestock::Equides::Yard);
nh3_npig_housing_and_yard	kg N /a	Annual NH3 emission from all pigs from all housings and yards. Sum(nh3_nhousing, Livestock::Pig::Housing) + Sum(nh3_nhousing, Livestock::FatteningPigs::Housing)
nh3_nfatteningpig_housing-_and_yard	kg N /a	Annual NH3 emission from fattening pigs from all housings and yards. Sum(nh3_nhousing, Livestock::FatteningPigs::Housing)
nh3_npig_application	kg N /a	Annual NH3 emission from application (estimation proportional to input of animalcategory in storage) Out(share_storage_pig) * Val(nh3_napplication, Application);

94.5 Detailed process description

95 Total

Agrammon Group – 2008-05-07

95.1 Short description

Summarize the Annual emissions from an Farm.

95.2 Input parameters

95.3 Technical parameters

95.4 Output

Parameter	Unit	Formula
nh3_ntotal	kg N /a	Annual NH3 emission from farm. Val('nh3_napplication', Application) + Val('nh3_nstorage', Storage) + Val('nh3_nlivestock', Livestock) + Val('nh3_nplantproduction', PlantProduction)
nh3_nanimalproduction	kg N /a	Annual NH3 emission from farm. Val('nh3_napplication', Application) + Val('nh3_nstorage', Storage) + Val('nh3_nlivestock', Livestock)

95.5 Detailed process description

This process summarizes the contribution of the individual Modules to the total NH3 emission from a farm.

96 Input Parameters

Parameter	Unit	Description

Livestock::DairyCow::Excretion

dairy_cows	-	Number of dairy cows in barn.

Livestock::DairyCow::Excretion::CMilk

milk_yield	kg /a	Annual milk yield per dairy cow.

Livestock::DairyCow::Excretion::CFeedSummerRatio

share_hay_summer	%	Proportion of animals receiving hay in summer.
share_maize_silage_summer	%	Proportion of animals receiving maize silage in summer.
share_maize_pellets_summer	%	Proportion of animals receiving maize pellets in summer.

Livestock::DairyCow::Excretion::CFeedWinterRatio

share_maize_silage_winter	%	Proportion of animals receiving maize silage in winter.
share_grass_silage_winter	%	Proportion of animals receiving grass silage in winter.
share_maize_pellets_winter	%	Proportion of animals receiving maize pellets in winter.
share_potatoes_winter	%	Proportion of animals receiving potatoes in winter.
share_beets_winter	%	Proportion of animals receiving beets in winter.

Livestock::DairyCow::Excretion::CConcentrates

amount_summer	kg /d	Amount of concentrates in summer per animal per day.
amount_winter	kg /d	Amount of concentrates in winter per animal per day.

Livestock::DairyCow::Housing::Type

housing_type	-	Type of housing. Possible values: `Loose_Housing_Deep_Litter`, `Loose_Housing_Slurry`, `Loose_Housing_Slurry_Plus_Solid_Manure`, `Tied_Housing_Slurry_Plus_Solid_Manure`, `Tied_Housing_Slurry`
dimensioning_barn	-	Number of available animal places.

Livestock::DairyCow::Housing::Floor

UNECE_category_1-_mitigation_options_for-_housing_systems_for_dairy-_cows	-	UNECE category 1 mitigation options for housing systems for other cattle(none, toothed scrapper running over a grooved floor). Possible values: `toothed_scrapper_running_over_a_grooved_floor`, `none`

Parameter	Unit	Description

Livestock::DairyCow::Yard

yard_days	d /a	Access to exercise yard in days per year.
exercise_yard	-	Exercise yard: not available, available: roughage is not supplied in the exercise yard, available: roughage is partly supplied in the exercise yard, available: roughage is exclusively supplied in the exercise yard. Possible values: available_roughage_is_exclusively_supplied_in_the_exercise_yard, available_roughage_is_not_supplied_in_the_exercise_yard, available_roughage_is_partly_supplied_in_the_exercise_yard, not_available
floor_properties_exercise_yard	-	Floor properties(solid floor, unpaved floor, perforated floor, paddock or pasture used as exercise yard). Possible values: paddock_or_pasture_used_as_exercise_yard, perforated_floor, unpaved_floor, solid_floor

Livestock::DairyCow::Grazing

grazing_days	d /a	Average grazing days per year.
grazing_hours	h /d	Average grazing hours per day.

Livestock::OtherCattle::Excretion

animalcategory	-	Animal category (suckling cows, 1 year old heifers, 2 years old heifers, 3 years old heifers, fattening calves, calves of suckling cows, beef cattle). Possible values: beef_cattle, calves_suckling_cows, fattening_calves, heifers_1st_yr, heifers_2nd_yr, heifers_3rd_yr, suckling_cows
animals	-	Number of animals for the selected type in barn.

Livestock::OtherCattle::Housing::Type

housing_type	-	Type of housing. Possible values: Loose_Housing_Deep_Litter, Loose_Housing_Slurry, Loose_Housing_Slurry_Plus_Solid_Manure, Tied_Housing_Slurry_Plus_Solid_Manure, Tied_Housing_Slurry

Parameter	Unit	Description
dimensioning_barn	-	Number of available animal places.

Livestock::OtherCattle::Housing::Floor

UNECE_category_1-_mitigation_options_for-_housing_systems_for_other-_cattle	-	UNECE category 1 mitigation options for housing systems for other cattle (none, toothed scrapper running over a grooved floor). Possible values: `toothed_scrapper_running_over_a_grooved_floor`, `none`

Livestock::OtherCattle::Yard

yard_days	d /a	Access to exercise yards days per year.
exercise_yard	-	Exercise yard: not available, available: roughage is not supplied in the exercise yard, available: roughage is partly supplied in the exercise yard, available: roughage is exclusively supplied in the exercise yard. Possible values: `available_roughage_is_exclusively_supplied_in_the_exercis` `available_roughage_is_not_supplied_in_the_exercise_yard`, `available_roughage_is_partly_supplied_in_the_exercise_yar` `not_available`
floor_properties_exercise_yard	-	Floor properties(solid floor, unpaved floor, perforated floor, paddock or pasture used as exercise yard). Possible values: `paddock_or_pasture_used_as_exercise_yard`, `perforated_floor`, `unpaved_floor`, `solid_floor`

Livestock::OtherCattle::Grazing

grazing_days	d /a	Average grazing days per year.
grazing_hours	h /d	Average grazing hours per day.

Livestock::Pig::Excretion

animalcategory	-	Pig category (nursing sows, dry sows, gilts, weaned piglets (up to 25kg), and boars). Possible values: `boars`, `dry_sows`, `gilts`, `nursing_sows`, `weaned_piglets_up_to_25kg`
pigs	-	Number of pigs for the selected type in barn.
crude_protein	g /kg	Crude protein content of feed ration.
energy_content	MJ VES /kg	Energy content of feed ration.

Livestock::Pig::Housing::Type

housing_type	-	Type of housing. Possible values: `Deep_Litter`, `Outdoor`, `Slurry_Label`, `Slurry_Conventional`

Parameter	Unit	Description

Livestock::Pig::Housing::AirScrubber

air_scrubber	-	Air exhaust scrubber (none, acid, biotrickling_filter). Possible values: acid, biotrickling, none

Livestock::Pig::Housing::UNECEhousingTask

UNECE_category_1-_mitigation_options_for-_housing_systems_for_pigs	-	UNECE housing tasks for partly slatted floor: with scraper (concrete_slats), with flush channels(no areation), with flush channels(areation), with flush gutters/tubes (no areation), with flush gutters/tubes (areation), with channels slanted walls(concrete slats), with channel slanted walls (metal slats), with scraper (metal slats). Possible values: with_channel_slanted_walls_metal_slats, with_channels_slanted_walls_concrete_slats, with_flush_channels_areation, with_flush_channels_no_areation, with_flush_gutters_tubes_areation, with_flush_gutters_tubes_no_areation, with_scraper_concrete_slats, with_scraper_metal_slats, none

Livestock::FatteningPigs::Excretion

fattening_pigs	-	Number of fattening pigs for the selected type in barn.
feeding_phase_1_crude-_protein	g /kg	Crude protein content of feed ration during phase 1.
feeding_phase_2_crude-_protein	g /kg	Crude protein content of feed ration during phase 2.
feeding_phase_3_crude-_protein	g /kg	Crude protein content of feed ration during phase 3.
energy_content	MJ VES /kg	Energy content of feed ration.

Livestock::FatteningPigs::Housing::Type

housing_type	-	Type of housing. Possible values: Deep_Litter, Outdoor, Slurry_Label, Slurry_Conventional

Livestock::FatteningPigs::Housing::AirScrubber

air_scrubber	-	Air exhaust scrubber (none, acid, biotrickling_filter). Possible values: acid, biotrickling, none

Parameter	Unit	Description

Livestock::FatteningPigs::Housing::UNECEhousingTask

UNECE_category_1-_mitigation_options_for-_housing_systems_for-_fattening_pigs	-	UNECE housing tasks for partly slatted floor: with scraper (concrete_slats), with flush channels(no areation), with flush channels(areation), with flush gutters/tubes (no areation), with flush gutters/tubes (areation), with channels slanted walls(concrete slats), with channel slanted walls (metal slats), with scraper (metal slats). Possible values: `with_channel_slanted_walls_metal_slats`, `with_channels_slanted_walls_concrete_slats`, `with_flush_channels_areation`, `with_flush_channels_no_areation`, `with_flush_gutters_tubes_areation`, `with_flush_gutters_tubes_no_areation`, `with_scraper_concrete_slats`, `with_scraper_metal_slats`, `none`

Livestock::Poultry::Excretion

animalcategory	-	Poultry category (layers, growers, broilers, turkeys, and other poultry). Possible values: `broilers`, `growers`, `other_poultry`, `turkeys`, `layers`
animals	-	Number of poultry animals for the selected type in barn.

Livestock::Poultry::Outdoor

free_range	-	Average free range hours per day. Possible values: `no`, `yes`

Livestock::Poultry::Housing::Type

housing_type	-	Type of housing. Possible values: `deep_litter`, `deep_pit`, `manure_belt`
manure_removal_interval	-	Manure removal interval by manure belt. Possible values: `3_to_4_times_a_month`, `more_than_4_times_a_month`, `no_manure_belt`, `twice_a_month`, `less_than_twice_a_month`

Parameter	Unit	Description
drinking_system	-	Type of drinking system. Possible values: bell_drinkers, drinking_nipples
droppings_mist_covered_basin	-	Droppings or mist covered basin. Possible values: no, yes

Livestock::Poultry::Housing::AirScrubber

air_scrubber	-	Exhaust air scrubber: none, acid, biotrickling_filter. Possible values: acid, biotrickling_filter, none

Livestock::Equides::Excretion

animalcategory	-	Animal category (horses younger than 3 years, horses older than 3 years, mules, ponies and asses). Possible values: horses_younger_than_3yr, mules, ponies_and_asses, horses_older_than_3yr
animals	-	Number of other animals for the selected type in barn.

Livestock::Equides::Grazing

grazing_days	d /a	Average grazing days per year.
grazing_hours	h /d	Average grazing hours per day.

Livestock::Equides::Yard

yard_days	d /a	Access to exercise yard in days per year.
yard_hours	h /d	Access to exercise yard in hours per day.
floor_properties_exercise_yard	-	Floor properties (solid_floor, unpaved_floor, paddock_or_pasture_used_as_exercise_yard). Possible values: paddock_or_pasture_used_as_exercise_yard, unpaved_floor, solid_floor

Livestock::SmallRuminants::Excretion

animalcategory	-	Animal category (Fattening sheep, milksheep and goats). Possible values: goats, milksheep, fattening_sheep

Parameter	Unit	Description
animals	-	Number of other animals for the selected type in barn.

Livestock::SmallRuminants::Grazing

grazing_days	d /a	Average grazing days per year.
grazing_hours	h /d	Average grazing hours per day.

Storage::Slurry

volume	m3	Volume of slurry store.
depth	m	Depth of slurry store.
mixing_frequency	-	Frequency of mixing of slurry store. Possible values: `13_to_20_times_per_year`, `21_to_30_times_per_year`, `3_to_6_times_per_year`, `7_to_12_times_per_year`, `more_than_30_times_per_year`, `1_to_2_times_per_year`

Storage::Slurry::EFLiquid

cover_type	-	Cover type of liquid storage. Possible values: `floating_cover`, `natural_crust`, `perforated_cover`, `solid_cover`, `tent`, `uncovered`
contains_cattle_manure	-	Describes if the specific storage contains cattle manure. Possible values: `no`, `yes`
contains_pig_manure	-	Describes if the specific storage contains pig manure. Possible values: `no`, `yes`

Storage::SolidManure::Poultry

share_applied_direct_poultry-_manure	%	Share of poultry manure applied to land without storage.

Storage::SolidManure::Solid

share_applied_direct_cattle-_other_manure	%	Share of cattle manure applied to land without storage.
share_applied_direct_pig-_manure	%	Share of pig manure applied to land without storage.

Application::Slurry::Ctech

share_splash_plate	%	Share of slurry applied with splash plate.
share_trailing_hose	%	Share of slurry applied with trailing hose.
share_trailing_shoe	%	Share of slurry applied with trailing shoes.
share_shallow_injection	%	Share of slurry applied with shallow injection.

Parameter	Unit	Description
share_deep_injection	%	Share of slurry applied with deep injection.

Application::Slurry::Applrate

dilution_parts_water	1:x	Specific slurry dilution. TAN contents have been calculated based on a standard dilution of 1:1 with a TAN content of 1.15 kg N /m3.
appl_rate	m3 /ha	Application rate, mean volume of slurry applied on a ha per deployment.

Application::Slurry::Csoft

appl_evening	%	Share of slurry applied in the evening after 18:00.
appl_hotdays	-	Proportion of slurry applied on hot days. Possible values: `never`, `rarely`, `sometimes`, `frequently`

Application::Slurry::Cseason

appl_summer	%	Share of slurry applied June to August.
appl_autumn_winter_spring	%	Share of slurry applied September to May.

Application::SolidManure::CincorpTime

incorp_lw1h	%	Share of incorporated solid manure within 1 hour.
incorp_lw4h	%	Share of incorporated solid manure within 4 hours.
incorp_lw8h	%	Share of incorporated solid manure within 8 hours.
incorp_lw1d	%	Share of incorporated solid manure within 1 day.
incorp_lw3d	%	Share of incorporated solid manure within 3 days.
incorp_gt3d	%	Share of incorporated solid manure after 3 days.
incorp_none	%	Share of solid manure not incorporated.

Application::SolidManure::Cseason

appl_summer	%	Share of solid manure applied June to August.
appl_autumn_winter_spring	%	Share of solid manure applied September to May.

PlantProduction::AgriculturalArea

agricultural_area	ha	Agricultural area.

PlantProduction::MineralFertiliser

mineral_nitrogen_fertiliser_urea	kg N /a	Amount of urea in kg N /a.
mineral_nitrogen_fertiliser_except_urea	kg N /a	Amount of nitrogen fertiliser (except urea) in kg N /a.

PlantProduction::RecyclingFertiliser

compost	t /a	Amount of compost (in t fresh matter per year). Kompost besteht aus GrÃ¼nabfÃ¤llen nicht-landwirtschafltícher Herkunft von gewerblich-industriellen Anlagen oder von Feldrandkompostierung.

Parameter	Unit	Description
solid_digestate	t /a	Amount of solid digestate form industrial factories.
liquid_digestate	m3 /a	Amount of liquid digestate form industrial factories.

97 Technical Parameters

Parameter	Value	Unit	Description

Livestock::DairyCow::Excretion

standard_N_excretion	115	kg N /a	Annual standard N excretion for a dairy cow according to Flisch et al. (2009).
share_Nsol	0.60	-	Nsol content of excreta. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
feed_influence_on_Nsol	1	kg Nsol /kg N	Proportion of N (calculated from feed ration correction) excreted as Nsol. Derived from e.g. Peterson et al. (1998).

Livestock::DairyCow::Excretion::CMilk

standard_milk_yield	6500	kg /a	Annual standard milk yield per dairy cow.
a_high	0.02	-	For milk yield > 6500
a_low	0.1	-	For milk yield < 6500

Livestock::DairyCow::Excretion::CFeed

d_summer	0.55	-	Duration of summer feeding period (200 days). Average for different altitude zones.
d_winter	0.45	-	Duration of the winter feeding period (165 days). Average for different altitude zones.

Livestock::DairyCow::Excretion::CFeedSummerRatio

c_hay_summer	-0.05	-	Modification of annual N excretion by adding hay to the standard ration during the summer feeding period.
c_maize_silage_summer	-0.08	-	Modification of annual N excretion by adding maize silage to the standard ration during summer feeding period.
c_maize_pellets_summer	-0.04	-	Modification of annual N excretion by adding maize pellets to the standard ration during summer feeding period.

Livestock::DairyCow::Excretion::CFeedWinterRatio

c_grass_silage_winter	0.027	-	Modification of annual N excretion by adding grass silage to the standard ration during winter feeding period.
c_maize_silage_winter	-0.016	-	Modification of annual N excretion by adding maize silage to the standard ration during winter feeding period.
c_maize_pellets_winter	-0.014	-	Modification of annual N excretion by adding maize pellets to the standard ration during winter feeding period.

Parameter	Value	Unit	Description
c_potatoes_winter	0.01	-	Modification of annual N excretion by adding potatoes to the standard ration during the winter feeding period.
c_beets_winter	0.019	-	Modification of annual N excretion by adding beets to the standard ration during the winter feeding period.

Livestock::DairyCow::Excretion::CConcentrates

par_a_summer	0.04	d /kg	Parameter a of linear regression a + b*x.
par_b_summer	-0.04	-	Parameter a of linear regression a + b*x.
par_a_winter	0.01	d /kg	Parameter a of linear regression a + b*x.
par_b_winter	-0.005	-	Parameter b of linear regression a + b*x.

Livestock::DairyCow::Housing::Type::Tied_Housing_Slurry

er	0.067	-	Emission rate for the tied housing slurry system for dairy cows. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 4% Ntot; converted using Nsol of 60%: EF 6.7% TAN.
share_liquid	1	-	For the tied housing slurry system 100% of the manure goes into the liquid fraction of the storage/application.
k_area	0	-	Additional surfaces are not used.

Livestock::DairyCow::Housing::Type::Tied_Housing_Slurry_Plus_Solid_Manure

er	0.067	-	Emission rate for the tied housing liquid solid system for dairy cows. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 4% Ntot, converted using Nsol of 60%: EF 6.7% TAN.
share_liquid	0.57	-	For the tied housing liquid solid system 57% of the manure goes into the liquid fraction of the storage/application.
k_area	0	-	Additional surfaces are not used.

Livestock::DairyCow::Housing::Type::Loose_Housing_Slurry

er	0.183	-	Emission rate for the loose housing slurry system for dairy cows. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 11% Ntot; converted using Nsol of 60%: EF 18.3% TAN. Reference value UNECE(2007): 11 kg HN3 = 8% TAN.
share_liquid	1	-	For the loose housing slurry system 100% of the manure goes into the liquid fraction of the storage/application.
k_area	0.5	-	According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: it is assumed that additional surfaces are entirely used since barriers are hardly fea-sible. The emission is increased by 5% per 10% of additional surfaces up to a maximum of 50% additional surface.

Parameter	Value	Unit	Description

Livestock::DairyCow::Housing::Type::Loose_Housing_Slurry_Plus_Solid_Manure

er	0.183	-	Emission rate for the loose housing liquid solid system for dairy cows. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 11% Ntot; converted using Nsol of 60%: EF 18.3% TAN. Reference value UNECE(2007): 11 kg NH3 = 8% TAN.
share_liquid	0.57	-	For the loose housing liquid-solid system 57% of the N of the manure goes into the liquid manure storage.
k_area	0.5	-	According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: it is assumed that additional surfaces are entirely used since barriers are hardly fea-sible. The emission is increased by 5% per 10% of additional surfaces up to a maximum of 50% additional surface.

Livestock::DairyCow::Housing::Type::Loose_Housing_Deep_Litter

er	0.183	-	Emission rate for the loose housing deep litter system for dairy cows. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 11% Ntot; convered using Nsol of 60%: EF 18.3% TAN. Reference value UNECE(2007): 11 kg NH3 = 8% TAN.
share_liquid	0	-	For the loose housing deep litter system 100% of the manure goes into the solid manure storage/application.
k_area	0.5	-	According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: it is assumed that additional surfaces are entirely used since barriers are hardly fea-sible. The emission is increased by 5% per 10% of additional surfaces up to a maximum of 50% additional surface.

Livestock::DairyCow::Housing::Floor

red_UNECE	0.25	-	Reduction efficiency as compared to cubicle house (UNECE 2007, paragraph 57, table 4).

Livestock::DairyCow::Yard

er_yard	0.7	-	Emission rate for TAN on yard.
share_available_roughage_is-_exclusively_supplied_in_the-_exercise_yard	0.6	-	Share of excretion per day for animals with roughage exclusively on the yard.
share_available_roughage_is-_partly_supplied_in_the-_exercise_yard	0.2	-	Share of excretion per day for animals with roughage partly on the yard.
share_available_roughage-_is_not_supplied_in_the-_exercise_yard	0.1	-	Share of excretion per day for animals with roughage not supplied in the yard.

Parameter	Value	Unit	Description
red_floor_properties_solid-_floor	0.0	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties_unpaved-_floor	0.5	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties-_perforated_floor	0.8	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties_paddock-_or_pasture_used_as-_exercise_yard	0.9	-	Reduction efficiency according to Reidy and Menzi.

Livestock::DairyCow::Grazing

er_dairycow_grazing	0.05	-	Emission rate for the calculation of the annual NH3 emission during grazing for dairy cows. 5% Ntot (conversion with a portion of Nsol of 60%: EF 8.3% TAN; value based on Table 1 (Mean emission rate of 3.1% N excreted; range: 1.6-5.7% for grazing cows on a sward fertilized with 250 kg N/y) of Bussink (1992) and Table 3 (Mean emission rate of 3.3% N excreted; range: 0.0-7.4% for grazing cows on a sward fertilized with 250 kg N/y) of Bussink (1994)). The corresponding value is rather lower for Switzerland since the level of fertilization is lower resulting in a lower level for crude protein. The N level in the fodder of the sward fertilized with 250 kg N/y (31 g/kg d.m.; Table 4) is comparable to values common for Switzerland (Bussink (1994)). The EF chosen includes a safety margin.

Livestock::DairyCow::Housing::KGrazing

k_grazing_reduction_lw5h	0	-	Reduction of housing emissions to 0% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw12h	0.2	-	Reduction of housing emissions to 20% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw22h	0.5	-	Reduction of housing emissions to 50% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_gt22h	1.0	-	Reduction of housing emissions to 100% due to extensive grazing/alping and milking using a mobile milking parlor. Empirical estimation.

Livestock::OtherCattle::Excretion

standard_N_excretion_heifers-_1st_yr	25	kg N /a	Annual standard N excretion for a 1 year old heifer, according to Flisch et al. (2009).
standard_N_excretion_heifers-_2nd_yr	40	kg N /a	Annual standard N excretion for a 2 year old heifer, according to Flisch et al. (2009).
standard_N_excretion_heifers-_3rd_yr	55	kg N /a	Annual standard N excretion for a 3 year old heifer, according to Flisch et al. (2009).
standard_N_excretion_beef-_cattle	33	kg N /a	Annual standard N excretion for a beefcattle, according to Flisch et al. (2009).
standard_N_excretion-_fattening_calves	13	kg N /a	Annual standard N excretion for a fatteningcalves, according to Flisch et al. (2009).
standard_N_excretion-_suckling_cows	80	kg N /a	Annual standard N excretion for a suckling cow, according to Flisch et al. (2009).

Parameter	Value	Unit	Description
standard_N_excretion_calves-_suckling_cows	34	kg N /a	Annual standard N excretion for calves of suckling cows, according to Flisch et al. (2009).
share_Nsol_heifers_1st_yr	0.6	-	Nsol content of excreta for 1 year old heifers. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_heifers_2nd_yr	0.6	-	Nsol content of excreta for 2 years old heifers. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_heifers_3rd_yr	0.6	-	Nsol content of excreta for 3 years old heifers. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_beef_cattle	0.6	-	Nsol content of excreta for beefcattle. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_fattening_calves	0.6	-	Nsol content of excreta for fatteningcalves. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_suckling_cows	0.6	-	Nsol content of excreta for suckling cows. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_calves_suckling-_cows	0.6	-	Nsol content of excreta for suckling cows. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).

Livestock::OtherCattle::Housing::Type::Tied_Housing_Slurry

er	0.067	Missing unit	Emission rate for the tide housing slurry system for cattle. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 4% Ntot, converted using Nsol of 60%: EF 6.7% TAN.
share_liquid	1	-	For the tide housing slurry system 100% of the manure goes into the liquid fraction of the storage/application.
k_area	0	-	Additional surfaces are not used.

Livestock::OtherCattle::Housing::Type::Tied_Housing_Slurry_Plus_Solid_Manure

er	0.067	-	Emisssion rate for the tide housing liquid solid system for cattle. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 4% Ntot; converted using Nsol of 60%: EF 6.7% TAN.
share_liquid	0.57	-	For the tide housing liquid solid system 57% of the manure goes into the liquid fraction of the storage/application.
k_area	0	-	Additional surfaces are not used.

Livestock::OtherCattle::Housing::Type::Loose_Housing_Slurry

er	0.183	-	Emission rate for the loose housing slurry system for cattle. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 11% Ntot; converted using Nsol of 60%: EF 18.3% TAN. Reference value UNECE(2007): 11 kg NH3 = 8% TAN.

Parameter	Value	Unit	Description
share_liquid	1	-	For the loose housing slurry system 100% of the manure goes into the liquid fraction of the storage/application.
k_area	0.5	-	According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: it is assumed that additional surfaces are entirely used since barriers are hardly fea-sible. The emission is increased by 5% per 10% of additional surfaces up to a maximum of 50% additional surface.

Livestock::OtherCattle::Housing::Type::Loose_Housing_Slurry_Plus_Solid_Manure

er	0.183	-	Emission rate for the loose housing liquid solid system for cattle. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 11% Ntot; convered using Nsol of 60%: EF 18.3% TAN. Reference value UNECE(2007): 11 kg NH3 = 8% TAN.
share_liquid	0.57	-	For the loose housing liquid solid system 57% of the manure goes into the liquid manure storage.
k_area	0.5	-	According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: it is assumed that additional surfaces are entirely used since barriers are hardly fea-sible. The emission is increased by 5% per 10% of additional surfaces up to a maximum of 50% additional surface.

Livestock::OtherCattle::Housing::Type::Loose_Housing_Deep_Litter

er	0.183	-	Emission rate for the loose housing deep litter system for cattle. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 11% Ntot; converted using Nsol of 60%: EF 18.3% TAN. Reference value UNECE(2007): 11 kg NH3 = 8% TAN.
share_liquid	0	-	For the loose housing deep litter system 100% of the manure does into the solid manure storage/application.
k_area	0.5	-	According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: it is assumed that additional surfaces are entirely used since barriers are hardly fea-sible. The emission is increased by 5% per 10% of additional surfaces up to a maximum of 50% additional surface.

Livestock::OtherCattle::Housing::Floor

red_UNECE	0.25	-	Reduction efficiency as comppared to cubicle house (UNECE 2007, paragraph 57, table 4).

Livestock::OtherCattle::Yard

er_yard	0.7	-	Emission rate for TAN on yard.
share_available_roughage_is-_exclusively_supplied_in_the-_exercise_yard	0.6	-	Share of excretion per day for animals with roughage exclusively on the yard.

Parameter	Value	Unit	Description
share_available_roughage_is-_partly_supplied_in_the-_exercise_yard	0.2	-	Share of excretion per day for animals with roughage partly on the yard.
share_available_roughage-_is_not_supplied_in_the-_exercise_yard	0.1	-	Share of excretion per day for animals with roughage not supplied in the yard.
red_floor_properties_solid-_floor	0.0	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties_unpaved-_floor	0.5	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties-_perforated_floor	0.8	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties_paddock-_or_pasture_used_as-_exercise_yard	0.9	-	Reduction efficiency according to Reidy and Menzi.

Livestock::OtherCattle::Grazing

er_cattle_grazing	0.05	-	Emission rate for the calculation of the annual NH3 emission during grazing for cattle. 5% Ntot (conversion with a portion of Nsol of 60%: EF 8.3% TAN; value based on Table 1 (Mean emission rate of 3.1% N excreted; range: 1.6-5.7% for grazing cows on a sward fertilized with 250 kg N/y) of Bussink (1992) and Table 3 (Mean emission rate of 3.3% N excreted; range: 0.0-7.4% for grazing cows on a sward fertilized with 250 kg N/y) of Bussink (1994). The corresponding value is rather lower for Switzerland since the level of fertilization is lower resulting in a lower level for crude protein. The N level in the fodder of the sward fertilized with 250 kg N/y (31 g/kg d.m.; Table 4) is comparable to values common for Switzerland (Bussink (1994). The EF chosen includes a safety margin.

Livestock::OtherCattle::Housing::KGrazing

k_grazing_reduction_lw5h	0	-	Reduction of housing emissions to 0% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw12h	0.2	-	Reduction of housing emissions to 20% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw22h	0.5	-	Reduction of housing emissions to 50% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_gt22h	1.0	-	Reduction of housing emissions to 100% due to extensive grazing/alping. Empirical estimation.

Livestock::Pig::Grazing

er_pig_grazing	0.2	-	Emission rate for the calculation of the annual NH3 emission during grazing for pigs. Sommer et al. (2001) give a yearly volatilization loss from one sow with piglets of 4.8 kg N resulting in a loss of 20% TAN assuming an N excretion/sow/y of 35 kg N (Flisch et al. (2009)).

Parameter	Value	Unit	Description

Livestock::Pig::Excretion

standard_N_excretion-_nursing_sows	42	kg N /a	Annual standard N excretion for animal category (nursing sows) according to Flisch et al. (2009).
standard_N_excretion_dry-_sows	20	kg N /a	Annual standard N excretion for animal category (dry sows) according to Flisch et al. (2009).
standard_N_excretion_gilts	13	kg N /a	Annual standard N excretion for animal category (gilts) according to Flisch et al. (2009).
standard_N_excretion-_weaned_piglets_up_to_25kg	4.6	kg N /a	Annual standard N excretion for animal category (piglets) according to Flisch et al. (2009).
standard_N_excretion_boars	18	kg N /a	Annual standard N excretion for animal category (boars) according to Flisch et al. (2009).
standard_crude_protein-_nursing_sows	165	g CP /kg	Standard crude protein content of a feed ration for nursing sows (BLW, SRVA, LBL 2003).
standard_crude_protein_dry-_sows	145	g CP /kg	Standard crude protein content of a feed ration for dry sows(BLW, SRVA, LBL 2003).
standard_crude_protein_gilts	170	g CP /kg	Standard crude protein content of a feed ration for gilts (BLW, SRVA, LBL 2003).
standard_crude_protein-_weaned_piglets_up_to_25kg	175	g CP /kg	Standard crude protein content of a feed ration for piglets (BLW, SRVA, LBL 2003).
standard_crude_protein_boars	145	g CP /kg	Standard crude protein content of a feed ration for boars (BLW, SRVA, LBL 2003).
standard_energy_content-_nursing_sows	12.5	MJ VES	Standard energy content of a feed ration for nursing sows (BLW, SRVA, LBL 2003).
standard_energy_content_dry-_sows	12.5	MJ VES	Standard energy content of a feed ration for dry sows (BLW, SRVA, LBL 2003).
standard_energy_content_gilts	13.5	MJ VES	Standard energy content of a feed ration for gilts (BLW, SRVA, LBL 2003).
standard_energy_content-_weaned_piglets_up_to_25kg	13.5	MJ VES	Standard energy content of a feed ration for piglets (BLW, SRVA, LBL 2003).
standard_energy_content-_boars	12.5	MJ VES	Standard energy content of a feed ration for boars (BLW, SRVA, LBL 2003).
cfeed_nursing_sows	0.007	-	Correction factor for feed with reduced crude protein content for nursing sows (BLW, SRVA, LBL 2003).
cfeed_dry_sows	0.008	-	Correction factor for feed with reduced crude protein content for dry sows (BLW, SRVA, LBL 2003).
cfeed_gilts	0.0054	-	Correction factor for feed with reduced crude protein content for gilts (BLW, SRVA, LBL 2003).
cfeed_weaned_piglets_up_to-_25kg	0.0072	-	Correction factor for feed with reduced crude protein content for piglets (BLW, SRVA, LBL 2003).
cfeed_boars	0.0052	-	Correction factor for feed with reduced crude protein content for boars (BLW, SRVA, LBL 2003).
minimal_N_excretion_nursing-_sows	35.3	kg N /a	Annual minimal N excretion for pig category (nursing sows) according to Flisch et al. (2009).
minimal_N_excretion_dry-_sows	17.5	kg N /a	Annual minimal N excretion for pig category (dry sows) according to Flisch et al. (2009).
minimal_N_excretion_gilts	10.9	kg N /a	Annual minimal N excretion for pig category (gilts) according to Flisch et al. (2009).
minimal_N_excretion_weaned-_piglets_up_to_25kg	3.8	kg N /a	Annual minimal N excretion for pig category (piglets) according to Flisch et al. (2009).
minimal_N_excretion_boars	15.5	kg N /a	Annual minimal N excretion for pig category (boars) according to Flisch et al. (2009).

Parameter	Value	Unit	Description
share_Nsol	0.7	-	Nsol content of excreta from pigs. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).

Livestock::Pig::Housing::Type::Slurry_Conventional

er	0.243	-	Emission rate for the conventional slurry pig housing system. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 17 % Ntot; converted using Nsol of 70%: EF 24.3 % TAN.
share_liquid	1	-	For the conventional slurry pig housing system 100% of the manure goes into the liquid fraction for storage/application.

Livestock::Pig::Housing::Type::Slurry_Label

er	0.486	-	Emission rate for the label slurry pig housing system. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 34 % Ntot; converted using Nsol of 70%: EF 48.6 % TAN.
share_liquid	1	-	For the label slurry pig housing system 100% of the manure goes into the liquid fraction for storage/application.

Livestock::Pig::Housing::Type::Deep_Litter

er	0.157	-	Emission rate for the label deep litter pig housing system. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 12.81 % Ntot; converted using Nsol of 70%: EF 18.3 % TAN
share_liquid	0	-	For the label deep litter pig housing system 100% of the manure goes into solid manure storage/application.

Livestock::Pig::Housing::Type::Outdoor

er	0	-	Emission rate for outdoor pigs (equal to zero because all emissions are listed under grazing).
share_liquid	0	-	For the outdoor pigs 0% of the manure goes into the liquid fraction for storage/application.

Livestock::Pig::Housing::AirScrubber

red_acid_air_scrubber	0.9	-	Reduction efficiency as compared to group-housed on fully and partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_biotrickling_filter_air_scrubber	0.7	-	Reduction efficiency as compared to group-housed on fully and partly slatted floors (UNECE 2007, paragraph 71, table 5).

Livestock::Pig::Housing::UNECEhousingTask

red_PSF_with_scraper_concrete_slats	0.4	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).

Parameter	Value	Unit	Description
red_PSF_with_flush-_channels_no_areation	0.5	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush-_channels_areation	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush_gutters-_tubes_no_areation	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush_gutters-_tubes_areation	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_channels-_slanted_walls_concrete_slats	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_channel-_slanted_walls_metal_slats	0.65	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_with_scraper-_metal_slats	0.5	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).

Livestock::FatteningPigs::Grazing

er_fattening_pig_grazing	0.2	-	Emission rate for the calculation of the annual NH3 emission during grazing for fattening pigs. Sommer et al. (2001) give a yearly volatilization loss from one sow with piglets of 4.8 kg N resulting in a loss of 20% TAN assuming an N excretion/sow/y of 35 kg N (Flisch et al. (2009)).

Livestock::FatteningPigs::Excretion

standard_N_excretion-_fattening_pigs	13	kg N /a	Annual standard N excretion for fattening pigs according to Flisch et al. (2009).
standard_energy_content-_fattening_pigs	13.5	MJ VES	Standard energy content of a feed ration for fattening pigs (BLW, SRVA, LBL 2003).
standard_crude_protein-_fattening_pigs	170	g CP /kg	Standard crude protein content of a feed ration for fattening pigs (BLW, SRVA, LBL 2003).
cfeed_fattening_pigs	0.008	-	Correction factor for feed with reduced crude protein content for fatteing pigs (BLW, SRVA, LBL 2003). A diffrence from 10 g CP /kg leads to 8 0/0 .
minimal_N_excretion-_fattening_pigs	10.9	kg N /a	Annual minimal N excretion for fattening pigs according to Flisch et al. (2009).
share_Nsol	0.7	-	Nsol content of excreta from fattening pigs. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
phase_1_3_duration	0.151	d	Feeding phase 1 of a 3-phase-feeding duration as part of the year.
phase_2_3_duration	0.321	d	Feeding phase 2 of a 3-phase-feeding duration as part of the year.
phase_3_3_duration	0.528	d	feeding phase 3 of a 3-phase-feeding duration as part of the year.

Parameter	Value	Unit	Description
phase_1_2_duration	0.359	d	Feeding phase 1 of a 2-phase-feeding duration as part of the year.
phase_2_2_duration	0.641	d	Feeding phase 2 of a 2-phase-feeding duration as part of the year.

Livestock::FatteningPigs::Housing::Type::Slurry_Conventional

er	0.243	-	Emission rate for the conventional slurry fattening pig housing system. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 17 % Ntot; converted using Nsol of 70%: EF 24.3 % TAN.
share_liquid	1	-	For the conventional slurry fattening pig housing system 100% of the manure goes into the liquid fraction for storage/application.

Livestock::FatteningPigs::Housing::Type::Slurry_Label

er	0.486	-	Emission rate for the label slurry fattening pig housing system. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 34 % Ntot; converted using Nsol of 70%: EF 48.6 % TAN.
share_liquid	1	-	For the label slurry fattening pig housing system 100% of the manure goes into the liquid fraction for storage/application.

Livestock::FatteningPigs::Housing::Type::Deep_Litter

er	0.157	-	Emission rate for the label deep litter fattening pig housing system. According to the consensus obtained in the workshop at ART TÃ¤nikon 02/11/07: 12.81 % Ntot; converted using Nsol of 70%: EF 18.3 % TAN
share_liquid	0	-	For the label deep litter fattening pig housing system 100% of the manure goes into solid manure storage/application.

Livestock::FatteningPigs::Housing::Type::Outdoor

er	0	-	Emission rate for outdoor fattening pigs (equal to zero because all emissions are listed under grazing).
share_liquid	0	-	For the outdoor fattening pigs 0% of the manure goes into the liquid fraction for storage/application.

Livestock::FatteningPigs::Housing::AirScrubber

red_acid_air_scrubber	0.9	-	Reduction efficiency as compared to group-housed on fully and partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_biotrickling_filter_air-_scrubber	0.7	-	Reduction efficiency as compared to group-housed on fully and partly slatted floors (UNECE 2007, paragraph 71, table 5).

Livestock::FatteningPigs::Housing::UNECEhousingTask

red_PSF_with_scraper-_concrete_slats	0.4	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).

Parameter	Value	Unit	Description
red_PSF_with_flush-_channels_no_areation	0.5	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush-_channels_areation	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush_gutters-_tubes_no_areation	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_flush_gutters-_tubes_areation	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_channels-_slanted_walls_concrete_slats	0.6	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_channel-_slanted_walls_metal_slats	0.65	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_PSF_with_with_scraper-_metal_slats	0.5	-	Reduction efficiency as compared to group-housed on partly slatted floors (UNECE 2007, paragraph 71, table 5).

Livestock::Poultry::Excretion

standard_N_excretion_layers	0.80	kg N /a	Annual standard N excretion for poultry category (layers) according to Flisch et al. (2009).
standard_N_excretion_growers	0.34	kg N /a	Annual standard N excretion for poultry category (growers) according to Flisch et al. (2009).
standard_N_excretion_broilers	0.45	kg N /a	Annual standard N excretion for poultry category (broilers) according to Flisch et al. (2009).
standard_N_excretion_turkeys	1.4	kg N /a	Annual standard N excretion for poultry category according (turkeys) to Flisch et al. (2009).
standard_N_excretion_other-_poultry	0.56	kg N /a	Annual standard N excretion for other poultry category according to Flisch et al. (2009).
share_Nsol_layers	0.6	-	Nsol content of excreta for layers. Derived from e.g. TODO
share_Nsol_growers	0.6	-	Nsol content of excreta for growers. Derived from e.g. TODO
share_Nsol_broilers	0.6	-	Nsol content of excreta for broilers. Derived from e.g. TODO
share_Nsol_turkeys	0.6	-	Nsol content of excreta for turkeys. Derived from e.g. TODO
share_Nsol_other_poultry	0.6	-	Nsol content of excreta for other poultry. Derived from e.g. TODO

Livestock::Poultry::Outdoor

er_free_range	0.7	-	Emission rate for free range poultry, based on Menzi et al. (1997): 70% of TAN or 28% of Ntot
free_range_days_layers	280	d /a	Average free range days per year.
free_range_hours_layers	2.88	h /d	Average free range hours per day, assumed is 12% of Day
free_range_days_growers	280	d /a	Average free range days per year.
free_range_hours_growers	2.88	h /d	Average free range hours per day, assumed is 12% of Day

Parameter	Value	Unit	Description
free_range_days_turkeys	280	d /a	Average free range days per year.
free_range_hours_turkeys	2.88	h /d	Average free range hours per day, assumed is 12% of Day
free_range_days_other-_poultry	280	d /a	Average free range days per year.
free_range_hours_other-_poultry	2.88	h /d	Average free range hours per day, assumed is 12% of Day
free_range_days_broilers	280	d /a	Average free range days per year.
free_range_hours_broilers	0.96	h /d	Average free range hours per day, assumed is 4% of Day

Livestock::Poultry::Housing::Type

er_housing_layers_growers-_manure_belt	0.15	-	Emission rate for the poultry housing type, based on EAGER workshop January 2007: 15% of Ntot, converted using 60% Nsol and emission factor of 25%.
er_housing_layers_growers-_deep_pit	0.30	-	Emission rate for the poultry housing type, based on EAGER workshop January 2007, UNECE 2007: 30% of Ntot, converted using 60% Nsol and emission factor of 50%.
er_housing_layers_growers-_deep_litter	0.30	-	Emission rate for the poultry housing type, based on EAGER workshop January 2007, UNECE 2007: 30% of Ntot, converted using 60% Nsol and emission factor of 50%.
er_housing_other_deep_litter	0.12	-	Emission rate for the poultry housing type, based on Reidy et al. (2009): 12% of Ntot, converted using 60% Nsol and emission factor of 20%.
c_manure_removal_interval-_less_than_twice_a_month TODO: Give better description!	1.2	-	Emission rate for the poultry manure removal by droppings belt. Empirical assumption by Reidy/Menzi.
c_manure_removal_interval-_twice_a_month TODO: Give better description!	1	-	Emission rate for the poultry manure removal by droppings belt. Empirical assumption by Reidy/Menzi.
c_manure_removal_interval-_3_to_4_times_a_month TODO: Give better description!	0.8	-	Emission rate for the poultry manure removal by droppings belt. Empirical assumption by Reidy/Menzi.
c_manure_removal_interval-_more_than_4_times_a-_month TODO: Give better description!	0.6	-	Emission rate for the poultry manure removal by droppings belt. Empirical assumption by Reidy/Menzi.
c_drinking_nipples	1.0	-	Emission rate for the poultry drinking type standard version.
c_bell_drinkers TODO: Give better description!	1.2	-	Emission rate for the poultry drinking type additional emission. Empirical assumption by Reidy/Menzi.
c_droppings_mist_covered-_basin	0.6	-	Emission rate for the droppings or mist covered basin for poultry.

Parameter	Value	Unit	Description

Livestock::Poultry::Housing::AirScrubber

red_acid_air_scrubber	0.9	-	Reduction efficiency as compared to group-housed on fully and partly slatted floors (UNECE 2007, paragraph 71, table 5).
red_biotrickling_filter_air-_scrubber	0.7	-	Reduction efficiency as compared to group-housed on fully and partly slatted floors (UNECE 2007, paragraph 71, table 5).

Livestock::Equides::Excretion

standard_N_excretion_horses-_younger_than_3yr	42	kg N /a	Annual standard N excretion for other animal category (horses younger than 3 years) according to Flisch et al. (2009).
standard_N_excretion_horses-_older_than_3yr	44	kg N /a	Annual standard N excretion for other animal category (horses older than 3 years) according to Flisch et al. (2009).
standard_N_excretion_mules	25.1	kg N /a	Annual standard N excretion for other animal category (mules) according to Flisch et al. (2009).
standard_N_excretion_ponies-_and_asses	15.7	kg N /a	Annual standard N excretion for other animal category (asses and ponies) according to Flisch et al. (2009).
share_Nsol_horses_younger-_than_3yr	0.4	-	Nsol content of excreta from horses younger than 3 years. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_horses_older-_than_3yr	0.4	-	Nsol content of excreta from horses older than 3 years. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_mules	0.4	-	Nsol content of excreta from mules. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_ponies_and_asses	0.4	-	Nsol content of excreta from asses and ponies. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).

Livestock::Equides::Housing

er_housing	0.11	-	Emission rate for loose housing with liquid, solid manure system is assumed (for TAN 0.275 and Nsol 40%).

Livestock::Equides::Grazing

er_equides_grazing	0.05	-	Emission rate for the calculation of the annual NH3 emission during grazing of equides. 5% Ntot (conversion with a protion of Nsol of 40%: EF 12.5% TAN). The emission rate is derived from Bussink et al. (1992, 1994), Jarvis et al. (1989), Peterson et al. (1998) and Ross and Jarvis (2001). (taking into account the generally low fertilization rate of Swiss pastures.)

Parameter	Value	Unit	Description

Livestock::Equides::Housing::KGrazing

k_grazing_reduction_lw5h	0	-	Reduction of housing emissions to 0% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw12h	0.2	-	Reduction of housing emissions to 20% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw22h	0.5	-	Reduction of housing emissions to 50% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_gt22h	1.0	-	Reduction of housing emissions to 100% due to extensive grazing/alping. Empirical estimation.

Livestock::Equides::Yard

er_yard	0.35	-	Emission rate for TAN on yard. Empirical estimation Kupper/Menzi, Keck(1997, Misselbrook et al. (2001)
red_floor_properties_unpaved-_floor	0.5	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties_solid-_floor	0.0	-	Reduction efficiency according to Reidy and Menzi.
red_floor_properties_paddock-_or_pasture_used_as-_exercise_yard	0.9	-	Reduction efficiency according to Reidy and Menzi.

Livestock::SmallRuminants::Excretion

standard_N_excretion_goats	16	kg N /a	Annual standard N excretion for goats according to Flisch et al. (2009).
standard_N_excretion-_fattening_sheep	15	kg N /a	Annual standard N excretion for fattening sheep according to Flisch et al. (2009).
standard_N_excretion-_milksheep	21	kg N /a	Annual standard N excretion for milksheep according to Flisch et al. (2009).
share_Nsol_goats	0.4	-	Nsol content of excreta from goats. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_fattening_sheep	0.4	-	Nsol content of excreta from fattening sheep. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).
share_Nsol_milksheep	0.4	-	Nsol content of excreta from milksheep. Derived from e.g. Peterson et al. (1998) or Burgos et al. (2005).

Livestock::SmallRuminants::Housing

er_housing	0.11	-	Emission rate for loose housing with liquid, solid manure system is assumed (for TAN 0.275 and Nsol 40%).

Livestock::SmallRuminants::Grazing

er_small_ruminants_grazing	0.05	-	Emission rate for the calculation of the annual NH3 emission during grazing of small ruminants. The emission rate is derived from Bussink et al. (1992, 1994), Jarvis et al. (1989), Peterson et al. (1998) and Ross and Jarvis (2001). (taking into account the generally low fertilization rate of Swiss pastures.)

Parameter	Value	Unit	Description

Livestock::SmallRuminants::Housing::KGrazing

Parameter	Value	Unit	Description
k_grazing_reduction_lw5h	0	-	Reduction of housing emissions to 0% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw12h	0.2	-	Reduction of housing emissions to 20% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_lw22h	0.5	-	Reduction of housing emissions to 50% due to extensive grazing/alping. Empirical estimation.
k_grazing_reduction_gt22h	1.0	-	Reduction of housing emissions to 100% due to extensive grazing/alping and milking using a mobile milking parlor. Empirical estimation.

Storage

Parameter	Value	Unit	Description
mineralizationrate_liquid	0.1	-	A netto mineralization of 10% from Norg to NSol/TAN is assuemd, according to the GAS_EM Model
immobilizationrate_solid	0.4	-	A netto immobilization of 40% from NSol/TAN to Norg is assuemd, according to the GAS_EM Model
immobilizationrate_poultry	0.4	-	A netto immobilization of 40% from NSol/TAN to Norg is assuemd, according to the GAS_EM Model

Storage::Slurry

Parameter	Value	Unit	Description
c_mixing_1_to_2_times_per_year	0.9	-	Correction for mixingfrequency in slurry storage. Based on DeBode(1990), Sommer et al.(1993), Menzi et al. (1997a)
c_mixing_3_to_6_times_per_year	0.95	-	Correction for mixingfrequency in slurry storage. Based on DeBode(1990), Sommer et al.(1993), Menzi et al. (1997a)
c_mixing_7_to_12_times_per_year	1	-	Correction for mixingfrequency in slurry storage. Default or Basis value
c_mixing_13_to_20_times_per_year	1.1	-	Correction for mixingfrequency in slurry storage. Empirical Estimation Reidy/Menzi
c_mixing_21_to_30_times_per_year	1.2	-	Correction for mixingfrequency in slurry storage. Empirical Estimation Reidy/Menzi
c_mixing_more_than_30_times_per_year	1.3	-	Correction for mixingfrequency in slurry storage.

Storage::Slurry::EFLiquid

Parameter	Value	Unit	Description
ef_cattle_uncovered	2.19	kg N /m2 /a	The emission factor for uncovered storage is based on experiments of de Bode (1990) and Sommer et al. (1993) measuring emissions of 2.5 to 6.9 g N m-2 day-1 for cattle slurry, for the emission of the none coverd a mean of the higher values is assumed. -> Assumption: 6.0 gN m-2 day-1 resp. 2.19 kg N /m2 /yr according to the results of the decision of the session of 10 April 208 (participants: C. Bonjour, C. Leuenbergern, M. Raaflaub, H. Menzi, T. Kupper).

Parameter	Value	Unit	Description
ef_cattle_solid_cover	0.219	kg N /m2 /a	Emission factor for solid covered storage based on ef_cattle_uncovered with a reduction of 90%. UNECE (2007) p 13 does suggest a reduction of 80%. Since covers of storages are more tight in Switzerland a reduction of 90% was choosen.
ef_cattle_tent	0.876	kg N /m2 /a	Emission factor for tent covered storage (ef_cattle_uncovered with a reduction of 60%) differs to the UNECE (2007) p.13 reference (ef_cattle_uncovered with a reduction of 80% after UNECE (2007))based on mutual agreement of AGRAMMON participants that newer studies showed that tent covered storage emit more ammonia then assumed by UNECE.
ef_cattle_floating_cover	0.438	kg N /m2 /a	Emission factor for floating covered storage (sheeting may be a type of plastic, canvas or other suitable material) (ef_cattle_uncovered with a reduction of 80%) differs to the UNECE (2007) p.13 referrence (ef_cattle_uncovered with a reduction of 60% after UNECE (2007))based on mutual agreement of AGRAMMON participants that newer studies showed that floating covered storage emit less ammonia then assumed by UNECE.
ef_cattle_perforated_cover	1.314	kg N /m2 /a	Emission factor for perforated_cover storage based on ef_cattle_uncovered with a reduction of 40% after UNECE (2007) p 13.
ef_cattle_natural_crust	1.314	kg N /m2 /a	Emission factor for a natural crust covered storage based on ef_cattle_uncovered with a reduction of 40% after UNECE (2007) p 13.
ef_pig_uncovered	2.92	kg N /m2 /a	The Emission factor for uncovered storage is based on experiments of de Bode (1990) and Sommer et al. (1993) measuring emissions of 2.5 to 6.9 g N m-2 day-1 for cattle slurry, for the emission of the none coverd a mean of the higher values is assumed. Assumption: 8.0 gN m-2 day-1 resp. 2.92 kgN m-2 /yr according to the report "AbklÃ¤rungen zur Klasierung von Stallsystemen und HofdÃ¼ngerlagern bezÃ¼glich der Ammoniak-Emissionen" and the decision of the session of 10 April 208 (participants: C. Bonjour, C. Leuenbergern, M. Raaflaub, H. Menzi, T. Kupper).
ef_pig_solid_cover	0.292	kg N /m2 /a	Emission factor for solid coverd storage based on ef_pig_uncovered with a reduction of 90%. UNECE (2007) p 13 does suggest a reduction of 80%.Since covers of storages are more tight in Switzerland a reduction of 90% was choosen.
ef_pig_tent	1.168	kg N /m2 /a	Emission factor for tent covered storage (ef_pig_uncovered with a reduction of 60%) differs to the UNECE (2007) p.13 referrence (ef_pig_uncovered with a reduction of 80% after UNECE (2007))based on mutual agreement of AGRAMMON participants that newer studies showed that tent covered storage emit more ammonia then assumed by UNECE.

Parameter	Value	Unit	Description
ef_pig_floating_cover	0.584	kg N /m2 /a	Emission factor for floating covered storage (sheeting may be a type of plastic, canvas or other suitable material) (ef_pig_uncovered with a reduction of 80%) differs to the UNECE (2007) p.13 reference (ef_pig_uncovered with a reduction of 60% after UNECE (2007))based on mutual agreement of AGRAMMON participants that newer studies showed that floating covered storage emit less ammonia then assumed by UNECE.
ef_pig_perforated_cover	1.752	kg N /m2 /a	Emission factor for perforated_cover storage based on ef_pig_uncovered with a reduction of 40% after UNECE (2007) p 13.
ef_pig_natural_crust	1.752	kg N /m2 /a	Emission factor for a natural crust covered storage (e.g. chopped straw, peat, bark, LECA balls, ect.)based on ef_pig_uncovered with a reduction of 40% after UNECE (2007) p 13.

Storage::SolidManure::Poultry

er_layers_growers_other-_poultry	0.15	-	Emission rate for layers, growers and other poultry for manure (deep pit, deep litter) and droppings (manure belt)(based on EAGER workshop, January 2008: 15% Ntot, converted using Nsol 60% and emission factor of 25%.
er_turkeys_broilers	0.06	-	Emission rate for manure of broilers and turkeys based on EAGER workshop, January 2008: 6% Ntot, converted using Nsol 60% and emission factor of 10%.

Storage::SolidManure::Solid

er_tan_pigs	0.5	-	The value has been derived from the Eager workshop, January 2008: (additional explanation following)
er_tan_cattle_other	0.3	-	The value has been derived from the Eager workshop, January 2008: (additional explanation following)

Application::Slurry

er_App_cattle_liquid	0.5	-	Emission rate for slurry application based on TAN of the slurry. The average rate has been derived from Sommer et al (2001b), Sogaard et al (2002), Menzi et al (1998), Menzi et al (1997a)
er_App_pigs_liquid	0.4	-	Emission rate for slurry application based on TAN of the slurry. The average rate has been derived from Sogaard et al (2002)

Application::Slurry::Ctech

red_splash_plate	0.0	-	There is no reduction for broadcasting with splash plate as to this way of applying slurry all the other methods are compared to.
red_trailing_hose	-0.3	-	Reduction efficiency as compared to broadcasting applying trailing hose. Adopted from UNECE (2007), Frick and Menzi (1997) and Menzi et al. (1997).

Parameter	Value	Unit	Description
red_trailing_shoe	-0.5	-	Reduction efficiency as compared to broadcasting applying trailing shoe. Adopted from UNECE (2007), Frick and Menzi (1997) and Menzi et al. (1997).
red_shallow_injection	-0.7	-	Reduction efficiency as compared to broadcasting applying shallow injection. Adopted from UNECE (2007), Frick and Menzi (1997) and Menzi et al. (1997).
red_deep_injection	-0.8	-	Reduction efficiency as compared to broadcasting applying deep injection. Adopted from UNECE(2007), Frick and Menzi (1997) and Menzi et al. (1997).

Application::Slurry::Applrate

norm_er	0.5	-	Standard emission of 50% of the applied TAN calculated based on an equation published by Menzi et al (1998) using a TAN standard of 1.15 kg /m3 for an 1:1 dilution, with application rate (AR) standard of 30 m3 /ha and average swiss meteorological conditions: ((19.41 * TAN_standard + 4.02 * 1.15 - 9.51) * (0.0214 * ARstandard + 0.36) / (AR_standard * TAN-standard)))

Application::Slurry::Csoft

c_evening	-0.2	-	Correction factor of the emission rate if slurry is applied in the evening (after 18h)(Menzi et al 1997; Frick and Menzi 1997). Assumption based on a single experiment with an application after 18h in August at a temperature of >20Â°C: reduction of the emission by 38%, the reduction of the emission averaged over the whole year is only 50%, i.e. -0.2 The correction is omitted for solid manure since infiltration into soil does not occur.
c_hotdays_frequently	0.1	-	Correction factor of the emission rate if slurry is applied frequently on hot days. Loss calculated according to the model of Katz (Menzi et al. 1997b) at 17Â°C (i.e. +5Â°C) compared to the reference temperature of 12Â°C (other parameters: 70% rela-tive air humidity, 1.15 kg/m3 TAN, 30 m3/ha) resulting in a loss of 19.22 kg N/ha at 17 Â°C and 55.7% TAN, respectively (compared to 17.45 kg N/ha and 50.6% TAN at 12Â°C, respectively) which corresponds to an increase of 10.1% (rounded to 10%).

Parameter	Value	Unit	Description
c_hotdays_sometimes	0.0	-	Correction factor of the emission rate if slurry is applied sometimes on hot days (estimation based on Menzi et al (1997)).
c_hotdays_rarely	-0.1	-	Correction factor of the emission rate if slurry is applied rarely on hot days (estimation based on Menzi et al (1997)).
c_hotdays_never	-0.2	-	Correction factor of the emission rate if slurry is applied never on hot days (estimation based on Menzi et al (1997)).

Application::Slurry::Cseason

c_summer	0.15	-	Correction factor for the application of slurry in summer (June to August): Model calculation according to the model of Katz (Menzi et al. 1997b) with meteorological data from Liebefeld 1993-2002: average from March to November 12Â°C, 70% relative air humidity, 1.15 kg/m3 TAN, 30 m3/ha resulting in a loss of 50.6% TAN; summer 17.8Â°C resulting in a loss of 56.7% TAN (+12%). Value chosen for cal-culation: +15%
c_autumn_winter_spring	-0.05	-	Correction factor for the application of slurry in autumn, winter and spring (Sept to May): Model calculation according to the model of Katz (Menzi et al. 1997b) with meteorological data from Liebefeld 1993-2002: average from March to November 12Â°C, 70% relative air humidity, 1.15 kg/m3 TAN, 30 m3/ha resulting in a loss of 50.6% TAN; spring/autumn/winter 9Â°C resulting in a loss of 48.1% TAN (-4.8%). Value chosen for calculation: -5%

Application::SolidManure

er_App_manure_dairycows-_cattle_pigs	0.8	-	Emission rate for manure application. The average rate has been derived from Frick et al. (1996) and Menzi et al. (1996). The value is based on the average emissions from diffrent Swiss experiments. Emission based on TAN of slurry.
er_App_manure_horses-_otherequides_smallruminants	0.7	-	Emission rate for manure application. The average rate has been derived from Frick et al. (1996) and Menzi et al. (1996). The value is based on the average emissions from diffrent Swiss experiments. Emission based on TAN of slurry.
TAN_share_solid	0.5	-	Share of TAN in applied solid manure.

Application::SolidManure::CincorpTime

eff_inc_lw1h	-0.9	-	Reduction due to incorporation of solid manure within 1 hour. UNECE (2007).
eff_inc_lw4h	-0.7	-	Reduction due to incorporation of solid manure within 4 hours. Empirical estimate deduced from UNECE (2007). Mean value between the category incorporation within 1 hour and incorporation within 8 hours.

Parameter	Value	Unit	Description
eff_inc_lw8h	-0.5	-	Reduction due to incorporation of solid manure within 8 hours. Values adapted from UNECE (2007) (category Incorporation by plough within 12 h)
eff_inc_lw1d	-0.35	-	Reduction due to incorporation of solid manure within 1 day. Values adapted from UNECE (2007) Empirical estimate deduced from Menzi et al. (1997).
eff_inc_lw3d	-0.3	-	Reduction due to incorporation of solid manure within 3 days. Empirical estimate deduced from Menzi et al. (1997).
eff_inc_gt3d	-0.1	-	Reduction due to incorporation of solid manure after 3 days Empirical estimate deduced from Menzi et al. (1997).
eff_inc_none	0.0	-	Basis with no incorporation of solid manure.

Application::SolidManure::Cseason

c_summer	0.15	-	Correction factor for the application of solid manure in summer (June to August): Model calculation according to the model of Katz (Menzi et al. 1997b) with meteorological data from Liebefeld 1993-2002: average from March to November 12Â°C, 70% relative air humidity, 1.15 kg/m3 TAN, 30 m3/ha resulting in a loss of 50.6% TAN; summer 17.8Â°C resulting in a loss of 56.7% TAN (+12%). Value chosen for cal-culation: +15%.
c_autumn_winter_spring	-0.05	-	Correction factor for the application of solid manure in autumn, winter and spring (Sept to May): Model calculation according to the model of Katz (Menzi et al. 1997b) with meteorological data from Liebefeld 1993-2002: average from March to November 12Â°C, 70% relative air humidity, 1.15 kg/m3 TAN, 30 m3/ha resulting in a loss of 50.6% TAN; spring/autumn/winter 9Â°C resulting in a loss of 48.1% TAN (-4.8%). Value chosen for calculation: -5%.

Application::PoultryManure

er_App_manure_layers-_growers_other_poultry	0.65	-	Emission rate for manure application. The average rate has been derived from Frick et al. (1996) and Menzi et al. (1996). The value is based on the average emissions from diffrent Swiss experiments. Emission based on TAN of slurry.
er_App_manure_turkeys-_broilers	0.3	-	Emission rate for manure application. The average rate has been derived from Frick et al. (1996) and Menzi et al. (1996). The value is based on the average emissions from diffrent Swiss experiments. Emission based on TAN of slurry.

Parameter	**Value**	**Unit**	**Description**
TAN_share_solid	0.5	-	Share of TAN in applied solid manure.

Application::PoultryManure::CincorpTime

eff_inc_lw1h	-0.95	-	Reduction due to incorporation of solid manure within 1 hour. UNECE (2007).
eff_inc_lw4h	-0.8	-	Reduction due to incorporation of solid manure within 4 hours. Empirical estimate deduced from UNECE (2007). Mean value between the category incorporation within 1 hour and incorporation within 8 hours.
eff_inc_lw8h	-0.7	-	Reduction due to incorporation of solid manure within 8 hours. Values adapted from UNECE (2007) (category Incorporation by plough within 12 h)
eff_inc_lw1d	-0.55	-	Reduction due to incorporation of solid manure within 1 day. Values adapted from UNECE (2007) Empirical estimate deduced from Menzi et al. (1997).
eff_inc_lw3d	-0.3	-	Reduction due to incorporation of solid manure within 3 days. Empirical estimate deduced from Menzi et al. (1997).
eff_inc_gt3d	-0.1	-	Reduction due to incorporation of solid manure after 3 days Empirical estimate deduced from Menzi et al. (1997).
eff_inc_none	0.0	-	Basis with no incorporation of solid manure.

PlantProduction::AgriculturalArea

er_agricultural_area	2	kg N /ha /a	Emission rate from the agricultural area. The average rate has been derived from Schjoerring and Mattson (2001). Emission based on kg/ ha AA (AA = agricultural area, Landwirschaftliche NutzflÃ¤che). N ist NH3 N.

PlantProduction::MineralFertiliser

er_App_mineral_nitrogen-_fertiliser_urea	0.15	-	Emission rate for the application of urea. The average rate has been derived from Vanderweerden and Jarvis (1997). Emission based on Ntot.
er_App_mineral_nitrogen-_fertiliser_except_urea	0.02	-	Emission rate for the application of ammonium nitrate. The average rate has been derived from Vanderweerden and Jarvis (1997). Emission based on Ntot.

PlantProduction::RecyclingFertiliser

er_compost 0.3 kg TAN per t fresh matter (Flisch et al., 2009). of TAN.	0.24	kg N / t	Emission rate from compost, calculated with an emmission rate of 80
er_solid_digestate	0.24	kg N / t	Emission rate for solid digestat from industrial plantse, calculated with an emmission rate of 80
er_liquid_digestate	1.2	kg N / t	Emission rate from liquid digestate from industrial plants, calculated with an emmission rate of 60

Parameter	Value	Unit	Description