Livestock: 3A2 Manure Management, including 3C6 indirect N_2O from Manure Management

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Outline

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  - Tier.2 Methodology for CH_4
  - Exercise of using the IPCC Software
- N_2O emissions from manure management
  - Methodologies for N_2O
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  - Exercise of using the IPCC Software: indirect N_2O emissions

Background

- When manure is stored or treated as a liquid (e.g., in lagoons, ponds, tanks, or pits), it decomposes anaerobically and produce CH_4.

- The main factors affecting CH_4 emissions are the amount of manure produced and the portion of the manure that decomposes anaerobically.

- Direct N_2O emissions occur by nitrification and denitrification of nitrogen contained in the manure. The emission of N_2O from manure during storage and treatment depends on the nitrogen and carbon content of manure, and on the duration of the storage and type of treatment.

Choice of estimation method for CH_4 emissions

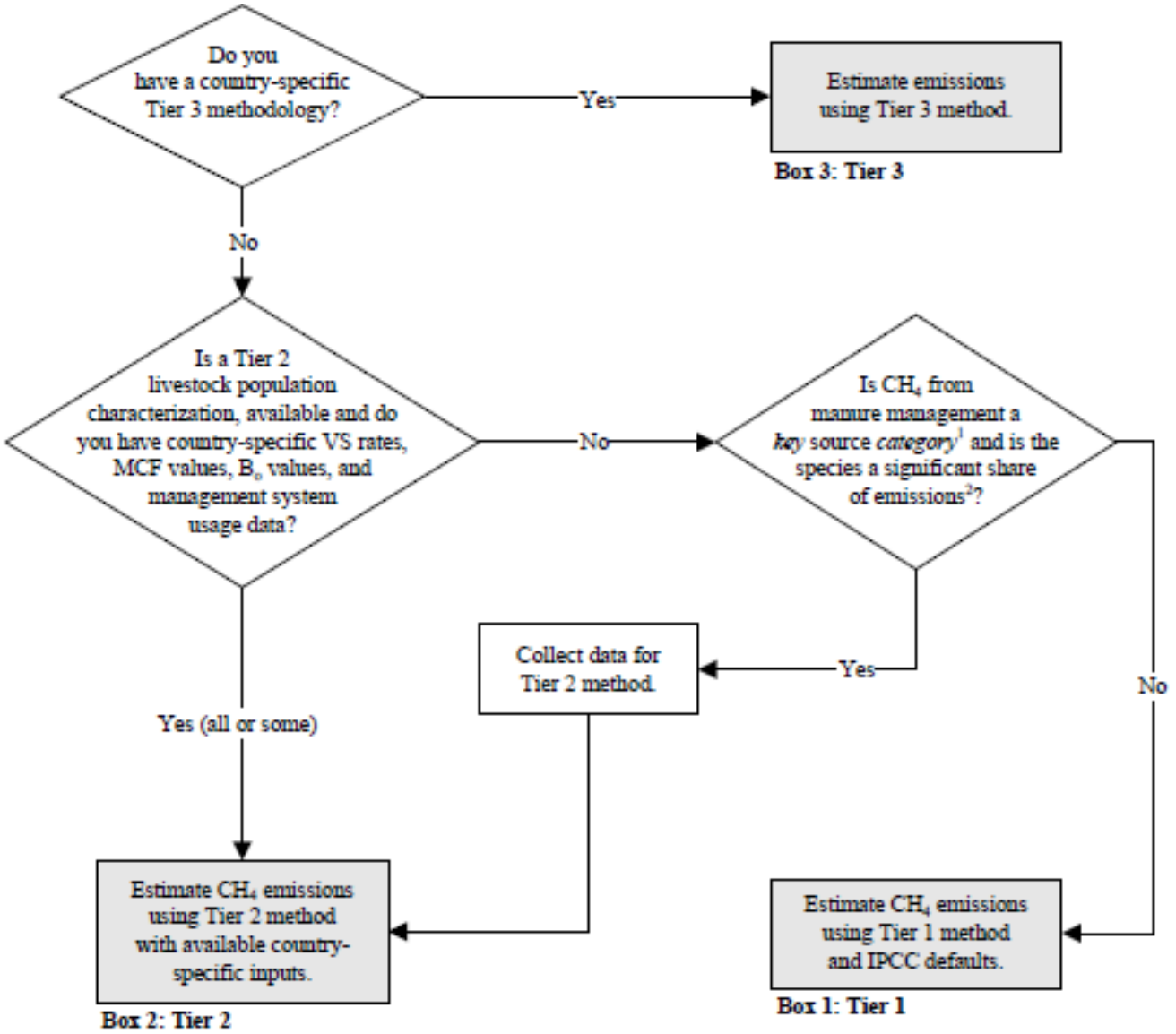
- Identify livestock subcategories: The same data developed in 3A1 can be used.
- Examine whether Tier.2 level estimation is possible or not. Availability of the following CS parameters is the threshold.
  - VS-ratio, MCF value, B_0 values, management system usage data.
- From the decision tree:
  - if the source occurs but not key source

    basic characterization – tier 1 – default EF
  - if the source occurs and key source:
    - for the significant species (normally cattle, sheep, swine) (cattle and sheep in RM 2015 inv.):

      enhanced characterization – tier 2 – CS EFs
  - for the non-significant species (normally, goats, camels, horses, asses, mules, poultry):

    basic characterization – tier 1 – default EF
- If relevant country specific science is available, application of Tier.3 may also be considered.

Decision tree: CH_4 emissions from Manure Management



Tier.1 methodology for CH_4 Manure Management

- Equation
  - Simply multiplying “animal population” and “EF (annual CH4 emission per head)

    Total $CH_{4\ Manure} = \Sigma [EF_{(T)} * N_{(T)}/10^6]$

    $EF_{(T)}$ = emission factor for the defined livestock population, kg CH_4 $head^{-1}$ yr^{-1}

    $N_{(T)}$ = the number of head of livestock species / Category T

- How to identify appropriate default EF
  - Default EFs for Tier.1 are provided by livestock species and by average annual temperature.
  - Refer the appropriate livestock category and the average annual temperature in RM.
  - Table 10.14 :for cattle, swine (and buffalo) for each region and each temperature(Not necessary for RM).
  - Table 10.15 :for sheep, goats, horses, mules/asses and poultry for developed /developing countries and for three climate zone.
  - Table 10.16: for deer, reindeer, and rabbit. No distinction between regions/temperature.

Tier.2 methodology for CH_4 Manure Management

- Basic Equation and activity data
  - The equation for Tier.2 is also multiplying “animal population” and “EF (annual CH_4 emission per head).
  - Activity data of animal population should be sub-divided into manure management type. The portion of manure management for each animal specie is necessary.

- EF for Tier.2
  - Considering the three factors to establish the EFs under Tier.2.
    - Daily volatile solid (VS) excreted rate (calculated from “gross energy intake”, “digestibility of the feed, and ash content of the manure).
    - Maximum amount of methane able to be produced from that manure (B_0).
    - Methane conversion factor (MCF) for each system by climate region.

  $EF_{(T)} = (VS*365)*[Bo_{(T)} * 0.67\ kg/m^3 *\Sigma\ (MCF_{(S,k)}/100 *MS_{(T,S,k)})]$ (equation 10.23)

  MS: fraction of livestock category T for manure management system S in climate region k.

  0.67: conversion factor from m^3 CH to kg CH_4

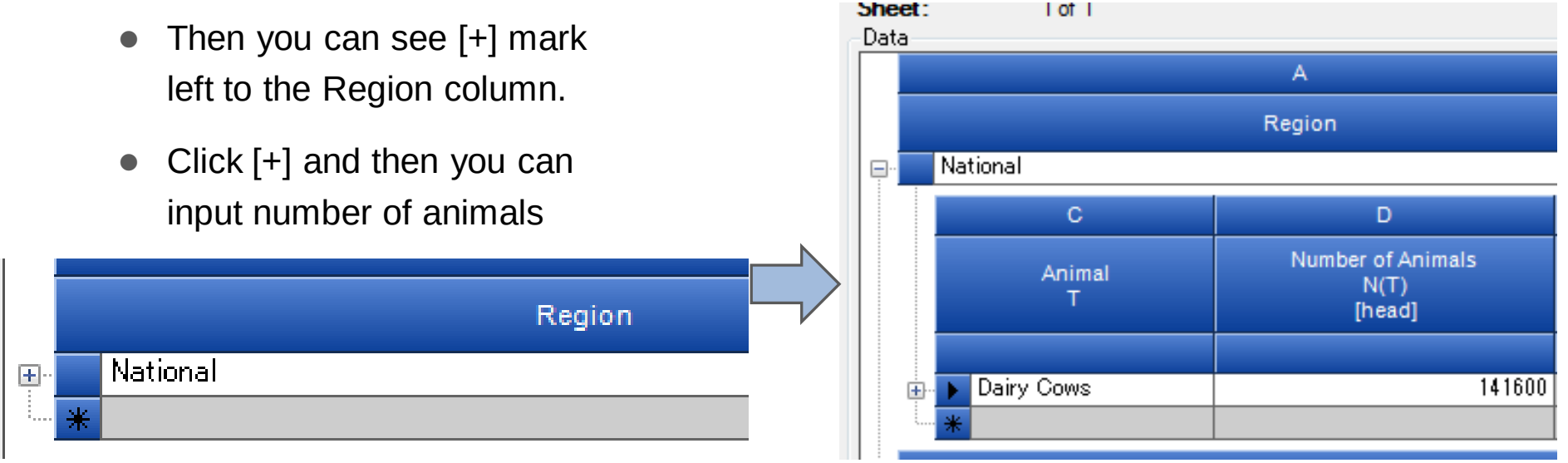
Tier.2 methodology for CH_4 Manure Management

- Fraction of manure management system (necessary to Tier.2)
  - Ideally CS data is used
  - Otherwise, regional data presented in Table 10A-4 (for Daily Cows), 10A-5 (for Other Cattle), 10A-7(Market Swine), 10A-8(Bleeding Swine) can be used.

Exercise by using the IPCC Software, 3A2-CH4

- Tiers to apply to CH_4: The following is the tiers in the 2015 inventory of Moldova.
  - Tier.2: Dairy Cows, Other Cattle, Swine (Market Swine, Fattening Piglets)
  - Tier.1:Sheep, Goats, Horses, Assess/Mules, Poulty, Rabbit
  - NO: Buffalo, Camels

- For 3A2 Manure Management, three tabs exist in the worksheet
  - Firstly, all necessary data should be filled in “Region, Livestock, MMS Association (manure management system)
    - Then you can see [+] mark left to the Region column.
    - Click [+] and then you can input number of animals



Exercise by using the IPCC Software, 3A2-CH4

- You move to the CH_4 tab. The entered number of animals is reflected into the CH_4 tab.
- At this moment, Tier.2 CH_4 EF is not able to estimate from source data through the software. (you have to estimate it by other tool such as excel.)
- In the CH_4 tab, you can select default EF which is automatically selected from EFs based on temperature information entered in advance, or enter Tier.2/CS EF to the relevant EF cell. Then the software calculates CH_4 emission.

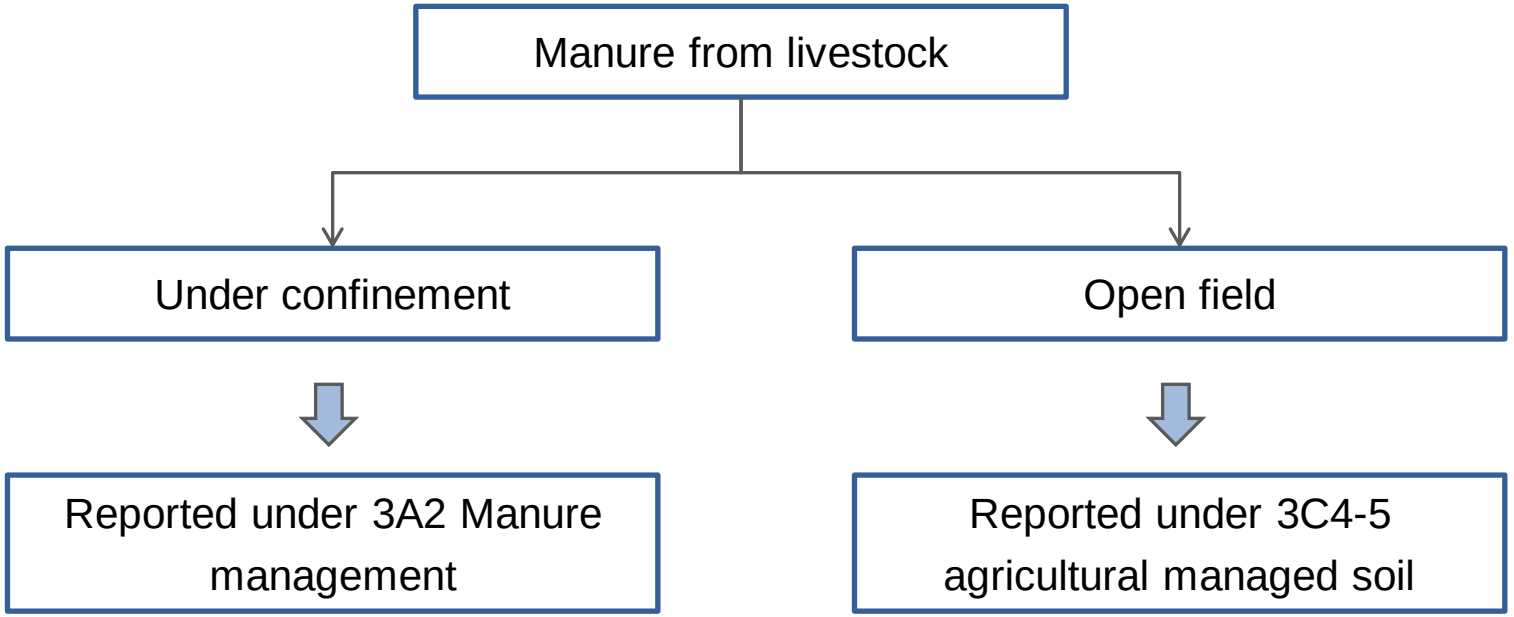
Sector: Agriculture, Forestry and Other Land Use
Category: Livestock/Manure Management
Subcategory: 3.A.2.a.i - Dairy cows
Sheet: 1 of 1

Data
Gas METHANE (CH4)

	T	N(T)	EF(T)	CH4
Region	Species/Livestock Category	Number of Animals (head)	Emission Factor [kg CH4/(head yr)]	CH4 Emissions (Gg CH4/yr)
				CH4 = N(T) * EF(T) * 10^-6
National	Dairy Cows	141600	5.46	0.77314
Total				0.77314

Notification relating to N2O Manure Management

- Special attention is necessary to the estimated category of N2O emission from manure



Choice of estimation method for N_2O emissions

- Identify livestock characterization and collect its population: The same data developed in 3A1 can be used, but single livestock characterization is necessary to be determined by;
  - annual average nitrogen excretion rate per head (Nex) for each animal species/category (T)
  - fraction of the total annual excretion for each livestock species/category that is managed with each manure management system type (MS)
  - N_2O emission factors (EF_3) for each manure management system type
- There are two type of N_2O emission: direct N_2O emission/ indirect N_2O emission:
  - Basically the same activity data are applicable to both.
  - For indirect N2O emission, Tier.1 covers volatilization of N (fraction of emitted as gas, and EF4 used), Tier.2 covers volatilization as well as leaching run off (fraction of runoff loss and EF5 used).
  - Volatilization is almost unavoidable process, while leaching is able to be prevented by anthropogenic management practice.

Choice of estimation method for N_2O emissions

- Activity data – required in addition to those necessary for the livestock characterization – are:
  - annual average N excretion per head/category/species
  - fraction of total annual excretion for each livestock species/category that is managed in a manure management system
- If no available data on the distribution of manure management systems, the Party should conduct a survey
- If not possible, values can be derived from expert opinions
- Parties are also encouraged to disaggregate the activity data for each major climatic zone

Methodology for direct N_2O emissions

- The same equation is applied to both Tier.1 and Tier.2.

EQUATION 10.25
DIRECT N_2O EMISSIONS FROM MANURE MANAGEMENT

$$N_2O_{D(mm)} = \left[\sum_S \left[\sum_T \left(N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)}\right)\right] \bullet EF_{3(S)}\right] \bullet \frac{44}{28}$$

Where:

$N_2O_{D(mm)}$ = direct N_2O emissions from Manure Management in the country, kg N_2O yr^{-1}

$N_{(T)}$ = number of head of livestock species/category *T* in the country

$Nex_{(T)}$ = annual average N excretion per head of species/category *T* in the country, kg N $animal^{-1}$ yr^{-1}

$MS_{(T,S)}$ = fraction of total annual nitrogen excretion for each livestock species/category *T* that is managed in manure management system *S* in the country, dimensionless

$EF_{3(S)}$ = emission factor for direct N_2O emissions from manure management system *S* in the country, kg N_2O-N/kg N in manure management system *S*

S = manure management system

T = species/category of livestock

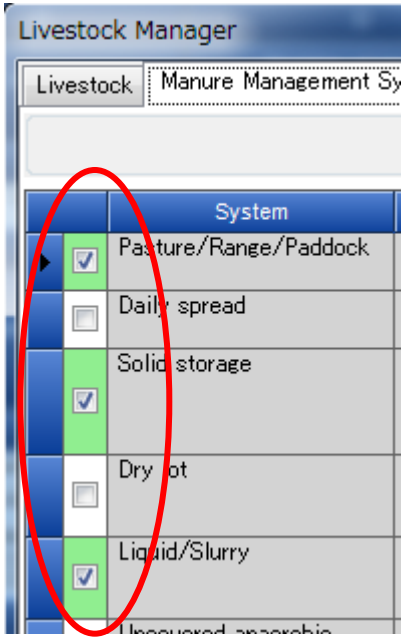
44/28 = conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions

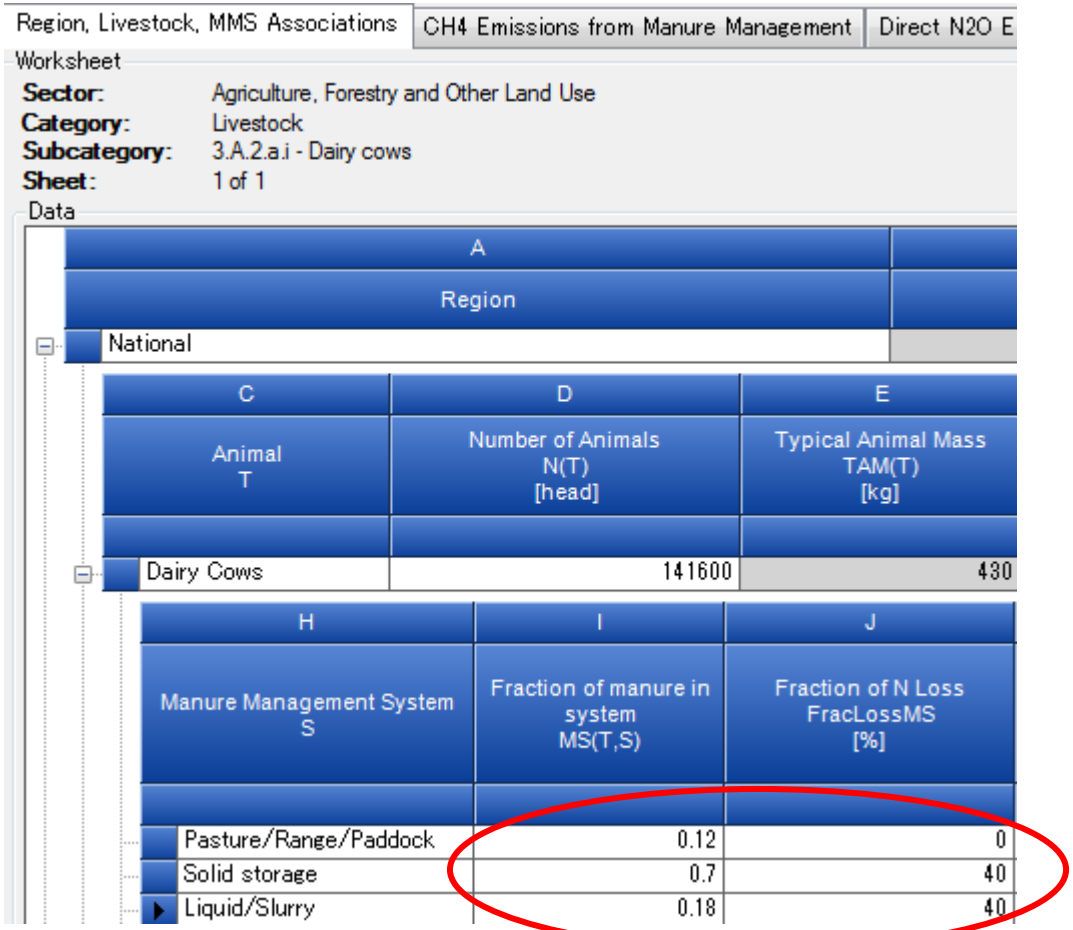
Tier.1 and Tier.2 for direct N_2O emissions

- The difference between Tier.1 and Tier.2 is mainly based the way estimating annual average N excretion per head of animal of species/category T ($Nex_{(T)}$).
- At this moment, Tier.1 type of $Nex_{(T)}$ calculation using “typical animal mass (TAM)” and “N excretion rate” is able to be done by the IPCC software. It allows to use both default parameter and/or country specific information. (So the same estimation applied by RM in the 2015 submission is reproductive).
- However, full Tier.2 type $Nex_{(T)}$ calculation is neither covered by nor entered into the software…

Exercise of using the IPCC Software for 3A2 N2O

- At first you should select the existing MMS in the livestock manager.
- Then enter the fraction of manure system in the “Region, Livestock, MMS Associations” tab.





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Exercise for 3A2 N2O

- Tier.1 calculation of $Nex_{(T)}$ can be done by livestock Manager tool, and this will automatically be reflected into the N_2O tab.
- Select or enter appropriate EF3 and then the software calculates direct N_2O emissions

Livestock Manager

Livestock | Manure Management System | Region

Save | Undo

Category	T	N(T)	TAM(T)	ER	Nex(T)
	Livestock Subcategory	Annual Average Population (head)	Typical Animal Mass (kg)	Excretion Rate per mass per day [kg N/(1000kg animal mass da	Excretion Rate per animal per year [kg N/(animal yr)]
					Nex(T) = TAM (T) / 1000 * 365 * ER
Dairy Cows	Dairy Cows	141600	430	0.35	54.9325

Region, Livestock, MMS Associations | CH4 Emissions from Manure Management | Direct N2O Emissions from Manure Management Systems

Worksheet

Sector: Agriculture, Forestry and Other Land Use
Category: Livestock/Manure Management
Subcategory: 3.A.2.a.i - Dairy cows
Sheet: 1 of 1 - Direct N2O Emissions from Manure Management Systems

Data

Gas NITROUS OXIDE (N2O)

Manure Management System	T	N(T)	Nrate(T)	TAM	Nex(T)	MS(T,S)	NEmms	EF3(S)	N2Od(mm)
Liquid/Slurry									
Region	Species/Livestock Category	Number of Animals (head)	Default N excretion rate (kg N (1000 kg Animal)^-1 Day^-1)	Typical animal mass for livestock category (kg)	Annual N excretion per head of species/livestock category^3 (kg N Animal^-1 Y	Fraction of total annual nitrogen excretion managed in M	Total nitrogen excretion for the MMS (kg N Year^-1)	Emission factor for direct N2O-N emissions from MMS (kg N2O-N/(kg N	Annual direct N2O emissions from Manure Management (kg N2O Year^-1)
					Nex(T) = Nrate(T) * TAM * 10^-3 * 365		NEmms = N(T) * Nex(T) * MS(T,S)		N2Od(mm) = NEmms * EF3(S) * 44/28
National	Dairy Cows	141600	0.35	430	54.9325	0.18	1400119.56	0.005	11000.9394

Exercise for 3C6

- For the estimation of indirect N_2O emissions from manure management, the calculated amount of N excreted in 3A2 is automatically reflected in 3C6 sheet 1 of 2.
- You just select the default parameters or enter CS ones about 1) percentage of volatilization of manure management, and 2)EF4.
- As reaching runoff is Tier.2, the IPCC software does not include this estimation worksheet. If a party wants to include this, using “3C8 other” is the only way to do.

Worksheet

Sector: Agriculture, Forestry and Other Land Use
Category: Aggregate Sources and Non-CO2 Emissions Sources on Land
Subcategory: 3.C.6 - Indirect N2O Emissions from manure management
Sheet: 1 of 2

2013

Data

Gas NITROUS OXIDE (N2O)

	S		T	NEmms	Frac(GasMS)	Nvolatilization-MMS	EF4	N2OG(mm)	
Region	Manure Management System	Livestock Category	Livestock	Total nitrogen excretion for the MMS (kg N / yr)	Fraction of managed livestock manure nitrogen that volatilises (-)	Amount of manure nitrogen that is lost due to volatilisation of NH3 and NOx (kg N / yr)	Emission factor for N2O emissions from atmospheric deposition of nitrogen on soils and water surfaces [kg N2O-N / (kg NH3-N + NOx-N volatilised)]	Indirect N2O emissions due to volatilization from Manure Management (kg N2O / yr)	
						Nvolatilization-MMS = NEmms * Frac (GasMS)		N2OG(mm) = NEvolatilization-MMS * EF4 * 44/	
National	Liquid/Slurry	Dairy Cows	Dairy Cows	17908506	0.4	716340.24	0.01	11256.7752	
	Solid storage	Dairy Cows	Dairy Cows	6964419	0.3	2089325.7	0.01	32832.261	
Total									

Uncertainty assessment

- The 2006GL provides the relevant information of uncertainties in section 10.5.5
  - Animal population: “vary widely depending on source, but should be known within ±20%
  - Nitrogen Excretion rate: ±50 %
  - EF3: -50 to +100%
- So the AD uncertainty is calculated by sqrt(20%^{2} +50%^{2}) = 53.85%
- This values are able to entered into the Uncertainty manager