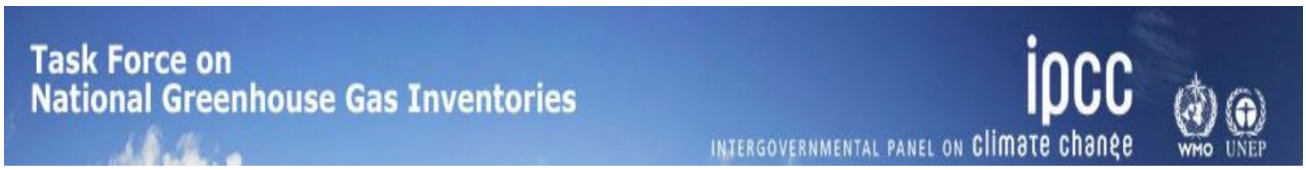

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LIVESTOCK CATEGORIES 3.A USERS' GUIDEBOOK

IPCC Inventory Software, version 2.90

Compiled by:

Technical Support Unit
IPCC Task Force on National Greenhouse Gas Inventories

This Guidebook is prepared by IPCC TFI TSU.
It has not been a subject to the formal IPCC review process
Please submit your feedback to ipcc-software@iges.or.jp

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Abbreviations

2006 IPCC Guidelines	2006 IPCC Guidelines for National Greenhouse Gas Inventories
2019 Refinement	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
AAP	annual average population
AD	activity data
C	carbon
CC	carbon content
EF	emission factor
GCV	gross calorific value
Gg	gigagram
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
IPCC TFI-TSU (or TSU)	Technical Support Unit of the IPCC Task Force on National Greenhouse Gas Inventories
kPa	kilopascal
l	litre
m^3	cubic meters
MMS(s)	Manure Management System(s)
NGHGI	national GHG inventory
TFI	IPCC Task Force on National Greenhous Gas Inventories
TJ	terajoule
Wetlands Supplement	2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands

I. Introduction

Goal

The guidebook for the IPCC Inventory Software (*Software*) is produced by the Technical Support Unit (TSU) of the IPCC Task Force on National Greenhous Gas Inventories (TFI) to support inventory compilers in the use of the *Software* for the preparation of national greenhouse gas (GHG) inventories through the description of the complete procedure from activity data (AD) organization and input, to emission factor (EF) selection and input, to GHG estimation and reporting.

Software users must be familiar with the *2006 IPCC Guidelines* methods and read the *Software*'s manual (downloadable from the "Help" menu) before going through this guidebook. This guidebook does not replace guidance provided in the *2006 IPCC Guidelines*.

Scope

The guidebook covers all methodological tiers and approaches provided in the *2006 IPCC Guidelines* and the *Wetlands Supplement*[1] to estimate anthropogenic GHG emissions and removals from each inventory category as well as to deal with cross-cutting elements. Elements of the *2019 Refinement*[2] are introduced in limited cases, where needed to enable interoperability between the *Software* and the UNFCCC electronic reporting tool for CRT.

Structure

Inventory preparation for each category, and each associated GHG, is described in this guidebook. Each section provides practical information to help the user enter information and estimate GHG emissions and removals for one or more categories from the *2006 IPCC Guidelines*[3]. Multiple categories (e.g. electricity generation and non-ferrous metals) are grouped together when the underlying instructions are the same for entering information in the *Software*. Table 1 below provides the definitions of various categories, as well as a hyperlink to the relevant section of the guidebook where further information may be found.

Each section is then presented with a parallel structure. General information on the category and gas(es) covered is provided, along with the relevant equations from the *2006 IPCC Guidelines* used to estimate GHG emission and removals in the *Software*. The section then introduces the worksheet(s) contained in the *Software* that are to be used to enter relevant activity data, emission factors and other parameters with a "User's work Flowchart" to help illustrate the user's series of steps to enter this information. Data may be entered either within a single nation-wide aggregate (i.e. "country name" geographical zone[4] or "unspecified") or within a national disaggregation such as administrative units (e.g. provinces, regions, states) or production units (e.g. companies, facilities, or any other aggregation according to which the user collects AD). Finally, the guidebook elaborates on the relevant activity data and emission factor input, and highlights how results are presented.

Finally, a word on selection of Tiers:

The *Software* provides functionalities -calculation worksheets and data managers- to prepare estimates according to any of the methodological tiers for which IPCC provides equations. Thus, in this Guidebook the following definitions are used to indicate the methodological tier of the relevant equations, and the correspondence with tiers in an NGHGI:

IPCC Tier 1 refers to the IPCC Tier 1 equations and default EFs/parameters.

Furthermore, recognizing that the *2006 IPCC Guidelines* allow reporting estimates produced with a Tier 3 user-specific[5] methodology, Tier 1 equations can be used to enter AD and Implied Emission Factor(s), as calculated by dividing the Tier-3 estimated GHG emission with the underlying AD required by the IPCC Tier 1 equation(s), to reproduce the estimated Tier 3 emissions.

IPCC Tier 2 refers:

- ✓ either to the IPCC Tier 2 equations, with IPCC default values or user-specific EFs/parameters, different from IPCC Tier 1 equations in the level of stratification and/or in the variables/parameters;
- ✓ or, when a Tier 2 Equation is not provided, to the IPCC Tier 1 equation and user-specific EFs/parameters (e.g. category 1.A.3.d water-borne navigation).

[1] Elements derived from the *Wetlands Supplement* are clearly distinguishable because of the liliac colour used to mark those.
[2] Elements derived from the *2019 Refinement* are clearly distinguishable because of magenta colour used to mark those.
[3] In few instances, denoted by magenta colour, from the 2019 Refinement.
[4] Please note that in other categories the sub-national stratification has been implemented within ***subdivisions*** while for category 3.A it has been implemented within ***geographical zones***.
[5] User-specific methodologies need anyhow to be accordant with IPCC *good practice* to satisfy the Transparency, Completeness, Consistency, Accuracy and thus Comparability reporting principles.

IPCC Tier 3 is the IPCC methodology different in the level of stratification and/or in the variables/parameters, from the IPCC Tier 1 and Tier 2 methodologies.

Tips

Stratification[6] of variables[7] used to calculate GHG emissions according to IPCC methodologies is a key element to promote accuracy and precision of estimates. Thus, the *Software* allows an unlimited input of elements for each of the variables and allows any combination of those.

Stratification is actually implemented in a two-way, by subdividing the entire category, in segments (geographical zones) and applying a single methodological tier, or subdividing the category in segments and applying different methodological tiers to different segments. Which means that within a category, those segments for which data are available -e.g. a specific technology for which EFs are known- are singled out[8] while all remaining are reported within a single aggregation[9], as e.g. *unspecified*[10].

However, the *Software* allows to enter each combination of variables, e.g. geographical zone/livestock category/subcategory/subdivision/MMS, only once. A way to further disaggregate such a combination across time series is through using e.g. the MMS name with a time-prefix. For instance, where the emission rate of an MMS changes across time, the addition of a prefix that indicates the MMS before and after a certain date where the change in the emission rate occurred, allows the user to implement such technological evolution within the current structure of stratification of the variables (e.g. *pre-year Y* and *post-year Y MMS X*).

Often worksheets have sub-layers that the user shall access to enter data. To do so, click on the element ⊞ on the left-hand side of worksheet. Once clicked the element ⊞ changes to ⊟.

Interoperability with the UNFCCC electronic reporting tool for the Common Reporting Tables (CRT)

The *Software* has been upgraded to be interoperable with the United Nations Framework Convention on Climate Change (UNFCCC) electronic reporting tool for the Common Reporting Tables (CRT) under the Enhanced Transparency Framework of the Paris Agreement.[11] In practice, that means that users of the *Software* can estimate GHG emissions and CO_2 removals for categories and gases that are required to be reported pursuant to the UNFCCC CRT. Once data are entered into the *Software*, users wishing to use these data to facilitate reporting to the UNFCCC must generate a file in the *Software* (in JSON format) that may then subsequently, through a separate UNFCCC platform, be uploaded and further processed through the UNFCCC electronic reporting tool for CRT.

A separate Guidebook, titled IPCC Inventory Software: UNFCCC Interoperability- CRT Export Quick Start Guide, has been developed to assist users in generating the JSON file for upload to the UNFCCC electronic reporting tool for CRT. Annex I illustrates the mapping of activity data and GHG estimates for categories/gases from the *Software* to the corresponding UNFCCC CRT category/ies.

[6] The larger the number of strata, the more accurate and precise the estimates are.
[7] Stratification is the act of sorting data into distinct groups or layers.
[8] By applying a higher tier method
[9] By applying a lower tier method
[10] This does not apply to variables required by IPCC Tier 1 method.
[11] As requested by Parties in decision 5/CMA.3, paragraphs 19 and 20.

II. Agriculture, Forestry and Other Land Use (AFOLU) Sector

The Agriculture, Forestry and Other Land Use (AFOLU) Sector integrates the previously separated *Agriculture* and *Land Use, Land-Use Change and Forestry* sectors. This integration recognizes that the processes underlying greenhouse gas emissions and removals, as well as the different forms of terrestrial carbon stocks, can occur across all types of land and that often the same practices influence both Agriculture and Land Use, Land Use Change and Forestry. This approach is intended to improve consistency and completeness in the estimation and reporting of greenhouse gas emissions and removals.

This Guidebook is limited to categories in the *Software* exclusively related to livestock, i.e. **3.A.1 - Enteric Fermentation**, **3.A.2 - Manure Management**, **3.C.6 - Indirect N_2O emissions from manure management**.

Table 1. Livestock-related categories included in the AFOLU sector of the 2006 IPCC Guidelines[12]

Categories	Definitions	Source/Sink
3.A - Livestock	*Methane emissions from enteric fermentation and methane and direct nitrous oxide emissions from manure management.*	
3.A.1 – Enteric Fermentation	*Methane emissions from herbivores as a by-product of enteric fermentation (a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream). Ruminant animals (e.g., cattle, sheep) are major sources with moderate amounts produced from non-ruminant animals (e.g., pigs, horses).*	
3.A.1.a - Cattle	*Methane emissions from dairy cows and other cattle.*	
3.A.1.a.i – Dairy cows	*Methane emissions from cattle producing milk for commercial exchange being grown for dairy purposes.*	
3.A.1.a.ii – Other cattle	*Methane emissions from all non-dairy cattle including cattle kept or grown for meat production, draft animals, and breeding animals.*	
3.A.1.b - Buffalo	*Methane emissions from buffalo.*	**Livestock Manager** **3.A - Livestock Population** **3.A - Average Daily Feed Intake** **3.A.1 - Enteric Fermentation - CH_4**
3.A.1.c - Sheep	*Methane emissions from sheep.*	
3.A.1.d - Goats	*Methane emissions from goats.*	
3.A.1.e - Camels	*Methane emissions from camels.*	
3.A.1f - Horses	*Methane emissions from horses.*	
3.A.1g – Mules and Asses	*Methane emissions from mules and asses.*	
3.A.1.h - Swine	*Methane emissions from swine.*	
3.A.1.j – Poultry	*Methane emissions from poultry. (this category has been added for interoperability with the UNFCCC ETF reporting tool*	
3.A.1.j – Other (please specify)	*Methane emissions from other livestock (e.g. alpacas, llamas, deer, reindeer, etc.).*	
3.A.2 – Manure management	*Methane and nitrous oxide emissions from the decomposition of manure under low oxygen or anaerobic conditions. These conditions often occur when large numbers of animals are managed in a confined area (e.g. dairy farms, beef feedlots, and swine and poultry farms), where manure is typically stored in large piles or disposed of in lagoons and other types of manure management systems.*	
3.A.2.a - Cattle	*Methane and direct nitrous oxide emissions from the decomposition of manure from dairy cows and other cattle.*	**Livestock Manager** **3.A - Livestock Population** **3.A - Average Daily Feed Intake** **3.A.2 - Manure Management – CH_4** **3.A.2 - Manure Management - Direct N_2O**
3.A.2.a.i – Dairy cows	*Methane and direct nitrous oxide emissions from the decomposition of manure from dairy cows.*	
3.A.2.a.ii – Other cattle	*Methane and direct nitrous oxide emissions from the decomposition of manure from other cattle.*	
3.A.2.b - Buffalo	*Methane and direct nitrous oxide emissions from the decomposition of manure from buffalo.*	

[12] as refined by the *2019 Refinement* for those categories relevant for the interoperability with the UNFCCC ETF reporting tool

Categories	Definitions	Source/Sink
3.A.2.c - Sheep	*Methane and direct nitrous oxide emissions from the decomposition of manure from sheep.*	Livestock Manager 3.A - Livestock Population 3.A - Average Daily Feed Intake 3.A.2 - Manure Management – CH_4 3.A.2 - Manure Management - Direct N_2O
3.A.2.d - Goats	*Methane and direct nitrous oxide emissions from the decomposition of manure from goats.*	
3.A.2.e - Camels	*Methane and direct nitrous oxide emissions from the decomposition of manure from camels.*	
3.A.2.f - Horses	*Methane and direct nitrous oxide emissions from the decomposition of manure from horses.*	
3.A.2.g – Mules and Asses	*Methane and direct nitrous oxide emissions from the decomposition of manure from mules and assess.*	
3.A.2.h – Swine	*Methane and direct nitrous oxide emissions from the decomposition of manure from swine.*	
3.A.2.i – Poultry	*Methane and direct nitrous oxide emissions from the decomposition of manure from poultry including chicken, broilers, turkeys, and ducks.*	
3.A.2.j – Oher (please specify)	*Methane and direct nitrous oxide emissions from the decomposition of manure from other livestock.*	
3.C.6 – Indirect N_2O emissions from manure management	*Indirect N_2O emissions from N volatilisation in forms of NH_3 and NO_X from manure management systems*	3.C.6 - Indirect N_2O emissions from Manure Management

Note: The category tree in the *Software* reflects the categories included in the *2006 IPCC Guidelines*, as refined by the *2019 Refinement* for those categories relevant for interoperability with the UNFCCC electronic reporting tool for CRT, plus those added by the *Wetlands Supplement*. Categories from the *2019 Refinement* are shown in this Guidebook, and in the *Software,* in a magenta colour.

II.1 General

II.1.1 Use of multiple tiers for reporting

The *2006 IPCC Guidelines* provide methodological guidance to estimate anthropogenic GHG emissions and removals according to three methodological tier levels: Tier 1, Tier 2, Tier 3. Where Tier 1 is the common default methodological approach that the IPCC Guidelines provide to all inventory compilers, higher tiers are based on user-specific and multivariable-dependent rates of GHG emissions and CO_2 removals, and likely requires data with a higher spatial and temporal resolution. Tier 2 may apply a different methodological approach, or the Tier 1 methodology approach with user-specific values for parameters and EFs, and may further disaggregate the population of activity data to apply condition-specific values of parameters and EFs[13]. Tier 3 is generally[14] a user-specific methodology that maintain consistency with IPCC *good practice*, although it is designed to better cope with the user-specific statistical population for which GHG emissions/removals are estimated or it is based on the direct monitoring of the source of GHG emissions.

Given that the *Software* can calculate GHG emissions and removals for each source/sink category using any of the methodological tiers provided in the *2006 IPCC Guidelines* and its *Wetlands Supplement*, the user may apply a single methodological tier to the entire category or may use instead a combination of different tiers according to the significance of subcategories and data availability.

In doing so the user shall transparently describe in any accompanying inventory report the original methodology and the way it has derived the implied EF.

While, as described above, the user may use a combination of tiers within a single source category, it may also wish to apply multiple tiers to the same activity as a means of quality control through comparative analysis (e.g. Tier 1 *vs* Tier 2 or Tier 2 *vs* Tier 3). Although this is a legitimate use of the *Software*, those comparative analysis shall be done in a separate database not used for reporting the GHG inventory, so avoiding to double count GHG emissions from a source.

Where a user-specific Tier 3 method, which cannot be calculated by the *Software*, is used to prepare estimates of GHG emissions that need to be included in the NGHGI for completeness, the user can use the relevant calculation worksheet(s) to report it as it follows:

1. enter in the *Software* the AD required by the IPCC default methodology.
2. back-calculate CO_2 and/or CH_4 and/or N_2O IEFs[15], as the total emissions of the relevant GHG calculated through the user-specific Tier 3 method divided by the AD required at bullet 1 above, and enter those in the *Software*.
3. the *Software* then reproduces the user-specific Tier 3 GHG estimates.

A dedicated geographical zone could be entered, e.g. specifically titled as "Tier 3" with any other identifying information, as appropriate.

[13] For example, the Tier 2 approach for CH_4 emissions from Manure management requires to calculate the Volatile Solid excretion rate to estimate the EF.
[14] In some cases, IPCC also provides a Tier 3 methodology, as for instance for CH_4 and N_2O emissions from Road transportation, although this is not the case for source-categories considered in this Guidebook.
[15] Implied Emission Factors

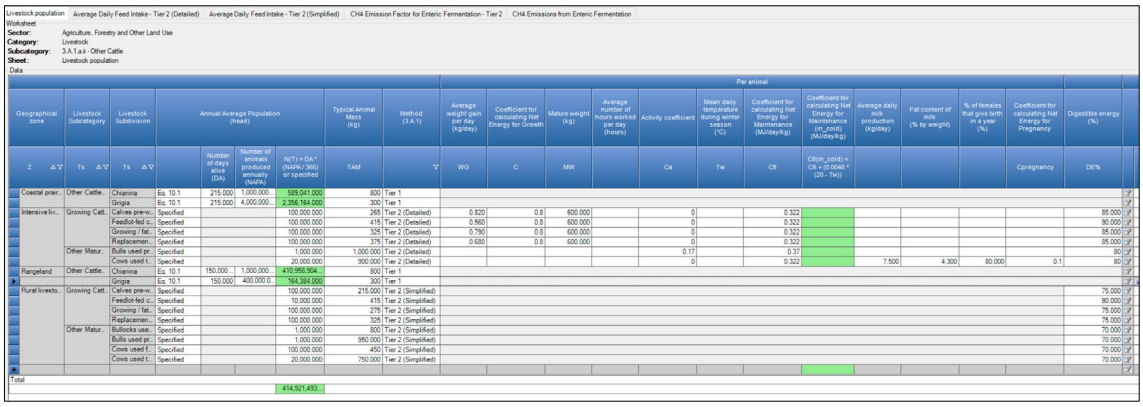
II.1.2 Reporting of Subdivisions

GHG inventories can be calculated at multiple levels of aggregation (e.g. farm, companies, regional, national) to meet various domestic and international needs. Thus, *Geographical zones* can be entered for all source categories in the Livestock-related categories (3.A, 3.C.6) in the AFOLU sector.

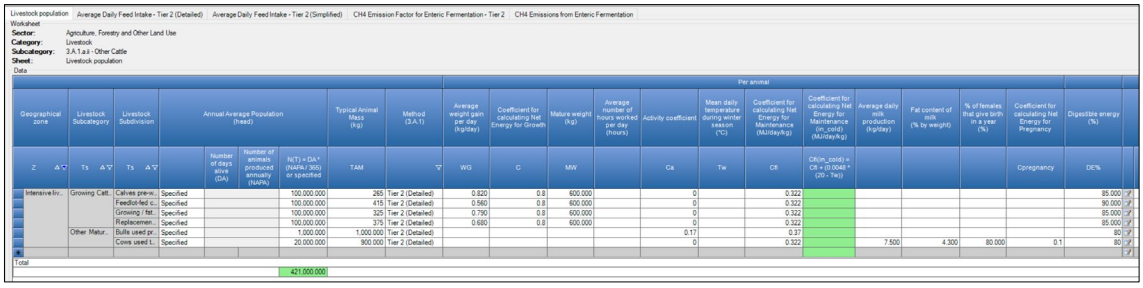
Where the user is interested in calculating GHG estimates at a single level of aggregation, e.g. national, in Column |S| either *unspecified* is to be selected from the dropdown menu or the single univocal name/code is to be entered e.g. the *country name*. Where the user is interested in calculating GHG estimates for multiple geographical zones, the univocal name/code for each geographical zone will be entered in Column |S|, users have full flexibility to name those geographical zones based on user-specific circumstances. Nevertheless, care shall be taken to ensure that s geographical zones do not overlap so causing a double counting of some emissions.

Every calculation worksheet[16] includes filters to enable the user to view data entry, by subdivision.

Example: **geographical zones**



Example: **visualizing filtered results**



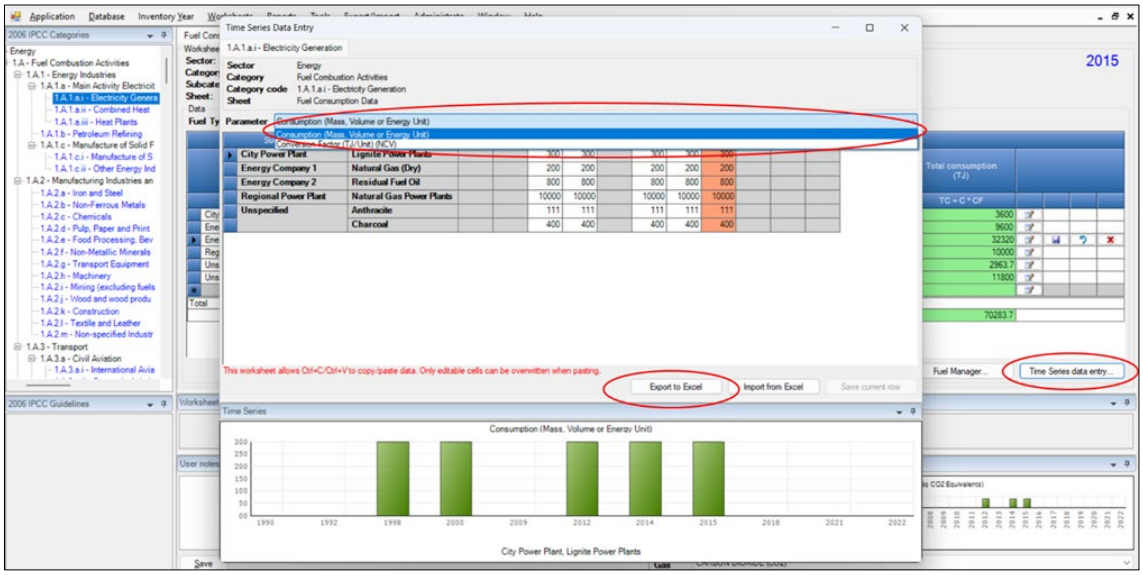
[16] Those can also be referred as TABs of the *Software*

II.1.3 "Uncertainty" and "Time Series data entry"

To enter data on *Uncertainties* or to enter *Time Series data*, calculation worksheets have dedicated tabs that can be accessed through buttons placed either at the lower right-hand side or next to the *Fuel type* button. Users are prompted to learn about how to use these functionalities in the *User Manual* of the *Software* (accessible at *Help* tab).

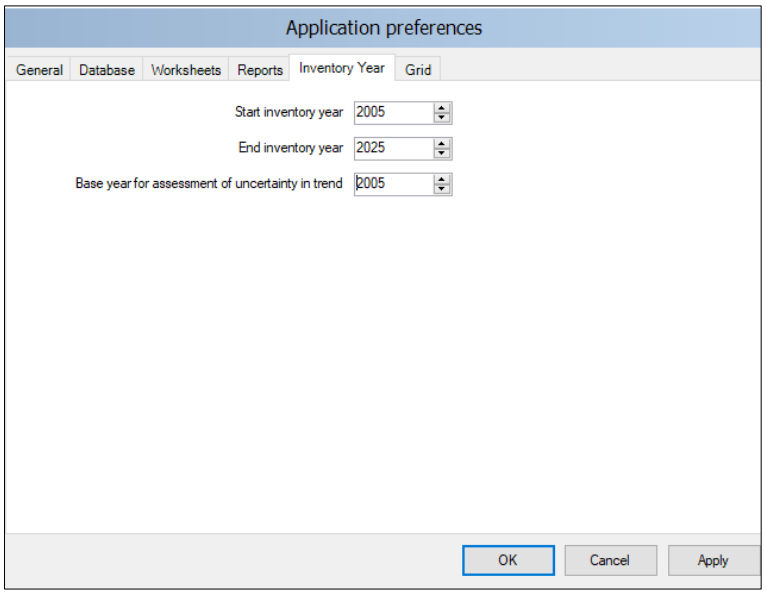
Time series data entry:

In each worksheet, there is a button "Time Series data entry" as shown in the screenshot below.



To use this functionality then users:

1. Select in TAB **Application**, sub-TAB **Inventory Year**, the time-period of the inventory:



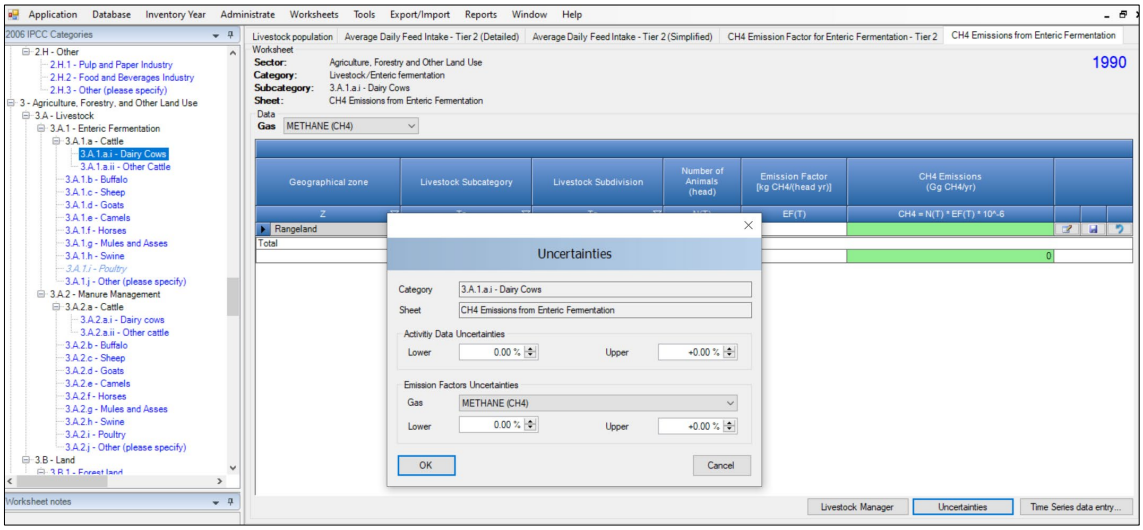
   and click on button *Apply* to save it.

2. select parameters for which the user wants to upload a time series of data from the *Parameters* bar. This list of parameters (e.g. consumption, conversion factors, EFs, etc.) depend on variables contained in the specific worksheet.
3. press the button *Export to Excel*, name the file and export it.
4. open exported file and for the entire time series, or for any fraction of it, enters data or make changes to data already present.
5. once data are compiled, the file is imported back into the *Software* by clicking the button *Import from Excel*.

Uncertainty:

Information on the underlying sources of uncertainty, and the default uncertainty values is available in the *2006 IPCC Guidelines* in the section titled *Uncertainty Assessment* of each source category.

Limited to calculation worksheets where emissions for a category are estimated, clicking the button *Uncertainties*, a pop-up window opens where users can enter lower and upper ranges of uncertainties for both AD and EF.



Please note that the Uncertainty Analysis has not yet been enhanced in this *Software* version, so this section is going to be revised in the next future.

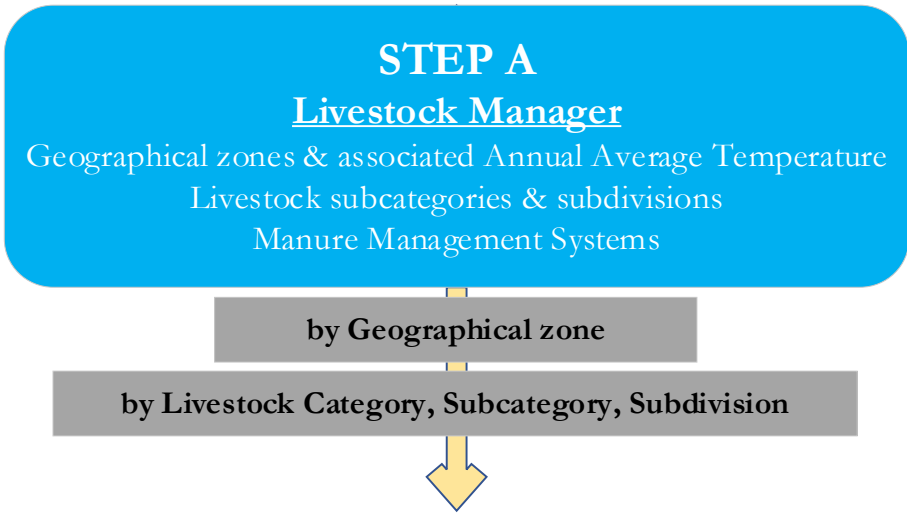
II.1.4 Livestock

Livestock emits CO_2, CH_4 and N_2O. However, CO_2 emissions from livestock are not estimated because annual net CO_2 emissions are assumed to balance to zero – i.e. the CO_2 photosynthesized by feed plants in annual biomass, which is not counted in the land categories, is returned to the atmosphere as respired CO_2 by the animals within the year.

Livestock manure management is a source of CH_4 emissions, likely substantial when manure is managed in a liquid form, and N_2O emissions, especially relevant when manure is managed in a solid form.

Unlike, IPCC default methodology (Tier 1) that requires a **basic characterisation** of livestock populations, IPCC Tier 2 requires an **enhanced characterisation** by sex-age-purpose in subcategories (e.g. beef cows) and, if data permits, in subdivisions (e.g. further stratified by age/ purpose/diet).

Livestock characterisation, to be entered in the **Livestock Manager**, is the **first step** when preparing GHG estimates of livestock-related categories i.e. **3.A.1 - Enteric Fermentation - CH_4**, **3.A.2 - Manure Management**, **3.C.6 - Indirect N_2O emissions from Manure Management**.



III. Livestock Manager

The Livestock manager aims at stratifying the livestock in more homogeneous subpopulations. It is composed by three TABs where users are required to enter information on:

1. the **Geographical Zones**, of which the territory inventoried is composed. Users can enter a number of geographical zones or just a single one only. This information is used by the sofwtare to assign a default CH_4 EF value[17] or a default Methane Conversion Factor value for emissions from Manure Management; and anyhow allows the user to stratify its inventory with different populations to which applying different methodological tier level according to data availability.
2. the **Livestock Characterisation**, requires users to enter a characterisation for each livestock population. The *Characterisation* users enter can be an *IPCC basic* or an *IPCC enhanced* or a *User-specific* or a combination of all of, or any of, those options. The *Software* then populates livestock-related calculation worksheets according to the livestock sub-categories/subdivisions entered in the *Livestock Characterisation*. A single *Characterisation* applies to all geographical zones.
3. the **Manure Management System**, requires users to select among IPCC default MMSs those to be applied in the inventory as well as to input any additional user-specific MMS. A single MMSs *Selection* applies to all geographical zones and all livestock populations.

Note: Information is to be entered in the **Livestock Manager** only once (in any inventory year) and applies to all livestock related categories:

Note: Information input the **Livestock Manager** can be thereafter modified, although the deletion of any information previously entered likely causes losses of data in the Livestock-related calculation worksheets where the information deleted was applied.

[17] 2019 Refinement stratifies it according to IPCC Climate Zones instead.

III.1 Geographical Zones

In this TAB, users:

a. Enter geographical zones (entire country may be reported under a single zone);

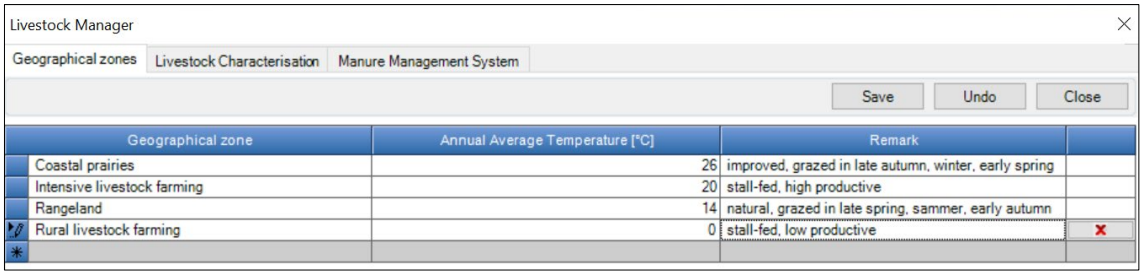
b. Select from drop-down menu average annual temperature (AAT) relevant to each geographical zone;

Note: Information on **Geographical Zones** is to be entered only once (in any inventory year)

Example of data input, a user enters 4 geographical zones: *Rangeland*, *Intensive Livestock farming*, *Rural Livestock farming*, *Coastal prairies*, with the following characteristics:

- ✓ *Rangeland*, natural grassland on highlands (cool climate, AAT of 14°C) extensively grazed, with manure left on pasture MMS = Pasture/Range/Paddock);
- ✓ *Intensive livestock farming*, farms in lowlands (temperate climate, AAT of 20°C) with high-productive husbandry systems, with a number of MMS specific of the different livestock populations;
- ✓ *Rural livestock farming*, farms in lowlands (temperate climate, AAT of 20°C) with low-productive husbandry systems, with a number of MMS specific of the different livestock populations;
- ✓ *Coastal land*, improved grazed coastal grasslands (warm climate, AAT of 26°C) with low-productive husbandry systems, with manure left on pasture MMS = Pasture/Range/Paddock:

Note that: same livestock population alternates between Rangeland and Coastal land (6 months each)



Geographical zone	Annual Average Temperature [°C]	Remark
Coastal prairies	26	improved, grazed in late autumn, winter, early spring
Intensive livestock farming	20	stall-fed, high productive
Rangeland	14	natural, grazed in late spring, sammer, early autumn
Rural livestock farming	0	stall-fed, low productive

Recall: enter information in the row with the asterisk on the left-hand side -i.e the bottom-most row- to add each geographical zone with its information.

Recall: *name* and *AAT* of a geographical zone can be re-entered without data loss in the calculation worksheet. However, where the ATT is re-entered, IPCC default CH_4 EF value for Manure Management may need to be re-entered given it is temperature-dependent, where not re-entered the sofwtare keeps the value previously entered.

Recall: click on button *SAVE* before closing the TAB, otherwise information entered will be lost.

III.2 Livestock Characterisation

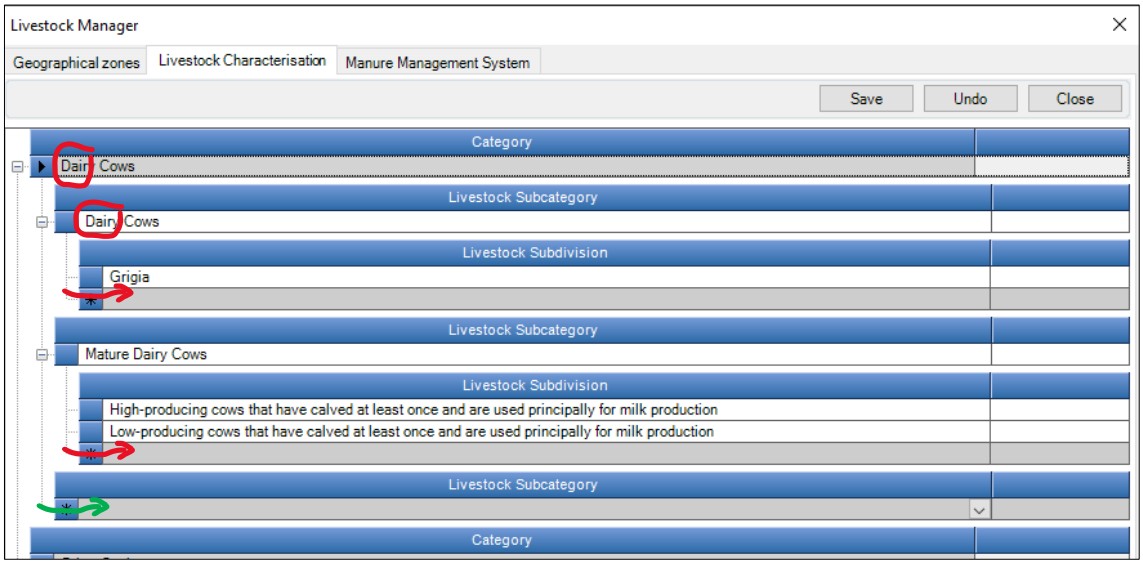
2006 IPCC Guidelines - Section 10.2 - contain guidance on livestock characterisation[18].

In this TAB users:

a. enter additional livestock populations, not yet listed in, if any;

b. for each livestock population for which GHG emissions need to be estimated for any subcategories/subdivisions, select predefined subcategories/subdivisions from the drop-down menu and/or enter user-specific livestock subcategories and, if any, subdivisions.

Note: Information on **Livestock Characterisation** is to be entered only once (in any inventory year)



Recall:

- enter additional livestock in the row with the asterisk on the left-hand side -i.e. the bottom-most row- 1 row for each additional livestock;
- click on ⊞ to open the lower levels[19] of the TAB; in this case clicking on ⊞ on the left-hand side of the category level opens the subcategory level and clicking on ⊞ on the left-hand side of the subcategory level opens the subdivision level. Once clicked ⊞, it changes to ⊟;
- enter information in the row with the asterisk on the left-hand side -i.e. the bottom-most row- to add sub-categories and subdivisions for the livestock population. In the figure above, for category *Dairy Cows* the green arrow indicates the bottom row where to enter an additional subcategory -1 row for each subcategory- and the red arrow indicates the bottom row where to enter an additional subdivision -1 row for each subdivision-;
- click on button *SAVE* before closing the TAB, otherwise information entered will be lost.

Note: where the characterisation of a livestock population among those listed does not have any subcategories and subdivisions no data enter is requested in the **Livestock Characterisation** TAB.

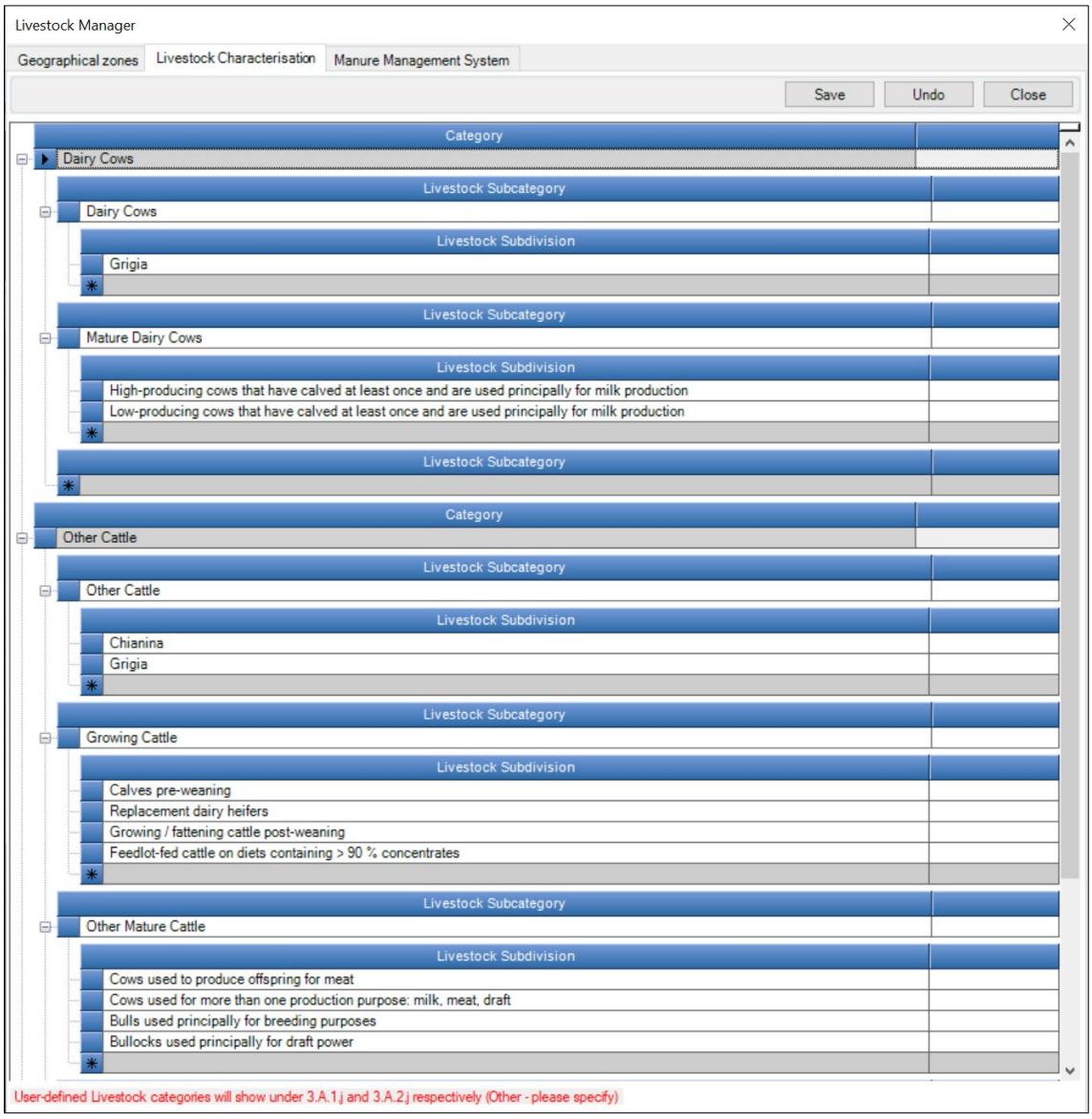
[18] IPCC Basic characterization and IPCC Enhanced characterization are provided in Table 10.1

[19] To access the lower levels of the livestock population characterisation (stratification)

Example of data input, a user has four geographical zones: *Rangeland*, *Intensive Livestock farming*, *Rural Livestock farming*, *Coastal prairies*, with the following livestock populations:

Geographical Zone	Category	Subcategory	Subdivision
Rangeland *Coastal prairies*	**Dairy Cows**	**Dairy Cows**	*Grigia*
	Other Cattle	**Other Cattle**	*Chianina*
			Grigia
	Sheep	**Mature Ewes**	Breeding Ewes
			Milking Ewes
		Growing Lambs	Intact Males
			Castrates
			Females
		Other Mature Sheep	NA
Intensive Livestock farming	**Dairy Cows**	**Mature Dairy Cows**	High-producing cows
	Other Cattle	**Growing Cattle**	Feedlot-fed Cattle (>90% concentrate)
			Calves pre-weaning
			Growing/Fattening post-weaning
			Replacement dairy heifers
		Other Mature Cattle	Cows to produce offspring for meat
			Multipurpose cows
			Bulls for breeding
	Swine	**Mature Swine**	Sows in gestation
			Sows nursing
			Boars for breeding
		Growing Swine	Nursery
			Finishing
			Gilts
			Growing Boars
Rural Livestock farming	**Dairy Cows**	**Mature Dairy Cows**	Low-producing cows
	Other Cattle	**Growing Cattle**	Feedlot-fed Cattle (>90% concentrate)
			Calves pre-weaning
			Growing/Fattening post-weaning
			Replacement dairy heifers
		Other Mature Cattle	Cows to produce offspring for meat
			Multipurpose cows
			Bulls for breeding
			Bullocks for draft power
	Swine	NA	NA

as compiled in the **Livestock Characterisation** TAB:



III.3 Manure Management Systems

2006 IPCC Guidelines -Vol.4, Table 10.18- contain definitions of IPCC default Manure Management Systems -MMS(s)-.

In this TAB, users enter any additional user-specific MMS at the bottom of the list.

Only those MMS that are listed in this TAB will be available for use in livestock-related calculation worksheets.

In the example below an additional MMS has been entered: *covered anaerobic lagoon*, with its description[20] -to enter a description of the MMS is very important to be sure you recall its characteristics, as well as to ensure that other users are informed about it.

Note: Information on **Manure Management Systems** is to be entered only once (in any inventory year)

Recall:

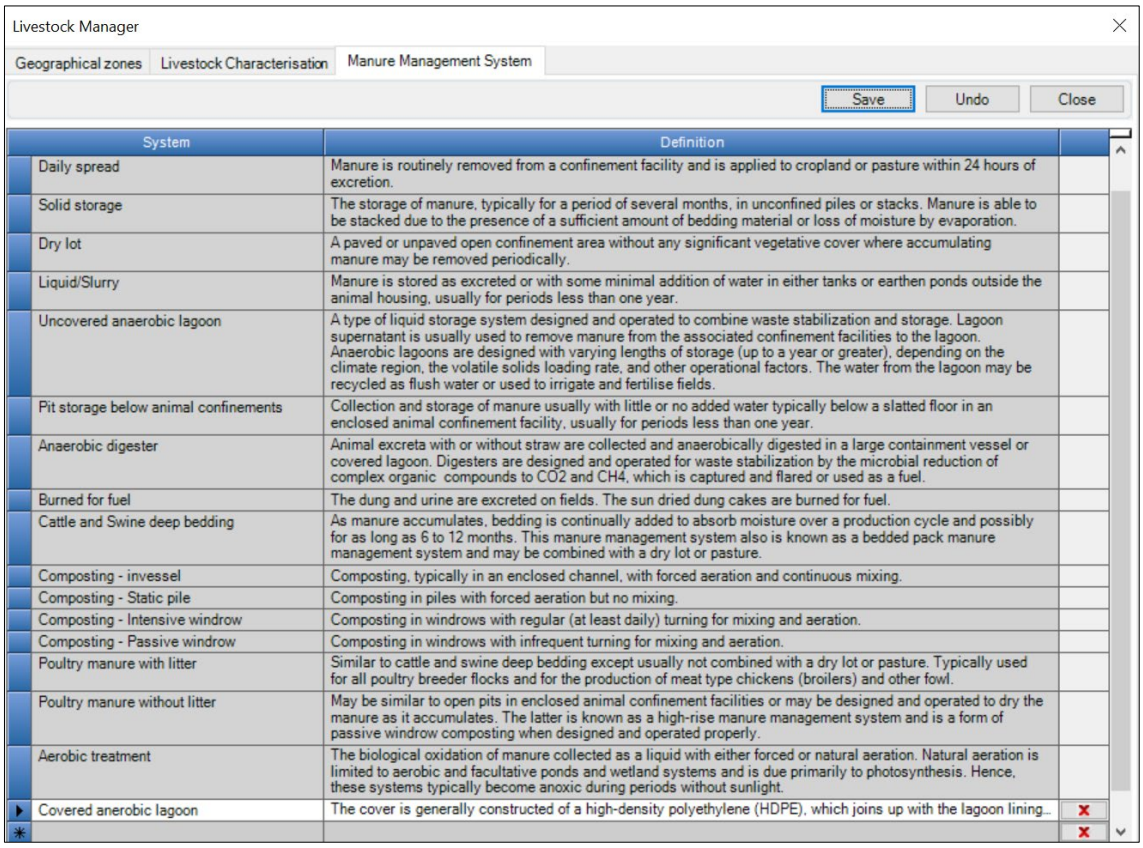
- enter additional MMS in the row with the asterisk on the left-hand side -i.e. the bottom-most row- 1 row for each additional MMS;
- click on button *SAVE* before closing the TAB, otherwise information entered will be lost.

[20] The cover is generally constructed of a high-density polyethylene (HDPE), which joins up with the lagoon lining and forms a 'seal', ensuring gas and odours remain under the cover.

Example of data input, a user has four geographical zones: *Rangeland*, *Intensive Livestock farming*, *Rural Livestock farming*, *Coastal prairies*, with the following livestock populations, to which the following MMSs apply:

Geographical Zone	Category	Subcategory	MMS
Rangeland *Coastal prairies*	**Dairy Cows**	**Dairy Cows**	Pasture/Range/Paddock
	Other Cattle	**Other Cattle**	
	Sheep	**Mature Ewes**	
		Growing Lambs	
		Other Mature Sheep	
Intensive Livestock farming	**Dairy Cows**	**Mature Dairy Cows**	Uncovered anaerobic lagoon
	Other Cattle	**Growing Cattle**	Pit storage
		Other Mature Cattle	Solid storage
	Swine	**Mature Swine**	Covered anaerobic lagoon
		Growing Swine	
Rural Livestock farming	**Dairy Cows**	**Mature Dairy Cows**	Deep Bedding
	Other Cattle	**Growing Cattle**	Dry lot
		Other Mature Cattle	Composting – passive windrow
	Swine	NA	Liquid slurry

as compiled in the **Manure Management System** TAB:



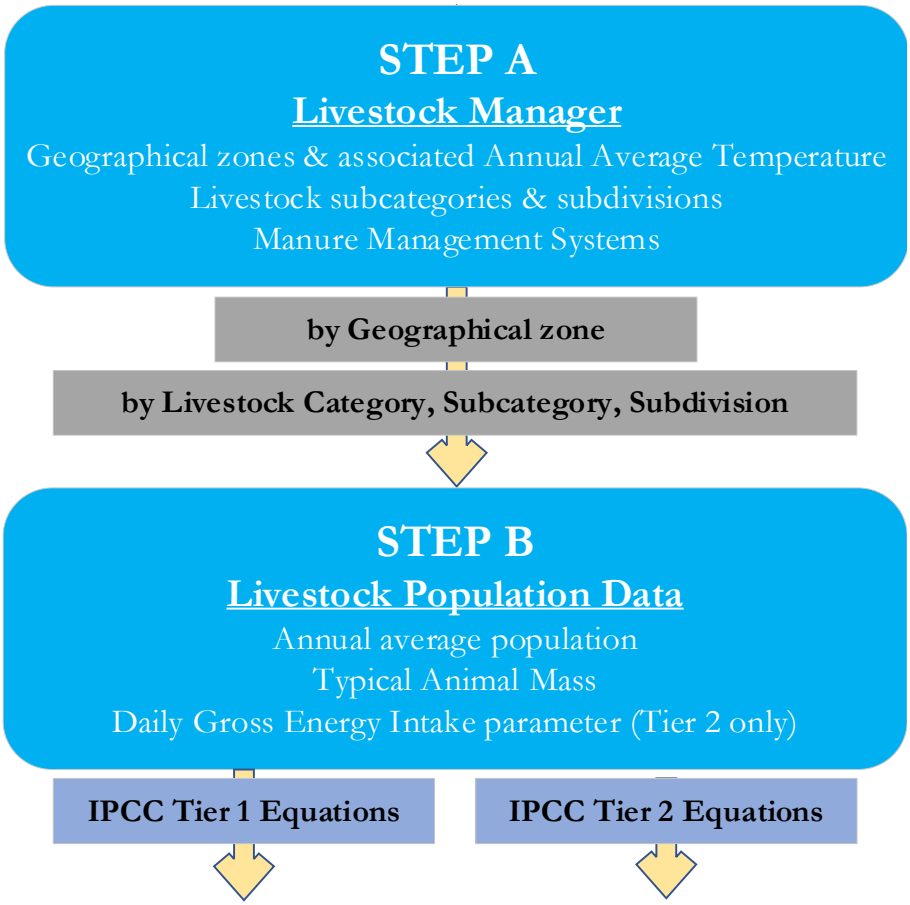
System	Definition
Daily spread	Manure is routinely removed from a confinement facility and is applied to cropland or pasture within 24 hours of excretion.
Solid storage	The storage of manure, typically for a period of several months, in unconfined piles or stacks. Manure is able to be stacked due to the presence of a sufficient amount of bedding material or loss of moisture by evaporation.
Dry lot	A paved or unpaved open confinement area without any significant vegetative cover where accumulating manure may be removed periodically.
Liquid/Slurry	Manure is stored as excreted or with some minimal addition of water in either tanks or earthen ponds outside the animal housing, usually for periods less than one year.
Uncovered anaerobic lagoon	A type of liquid storage system designed and operated to combine waste stabilization and storage. Lagoon supernatant is usually used to remove manure from the associated confinement facilities to the lagoon. Anaerobic lagoons are designed with varying lengths of storage (up to a year or greater), depending on the climate region, the volatile solids loading rate, and other operational factors. The water from the lagoon may be recycled as flush water or used to irrigate and fertilise fields.
Pit storage below animal confinements	Collection and storage of manure usually with little or no added water typically below a slatted floor in an enclosed animal confinement facility, usually for periods less than one year.
Anaerobic digester	Animal excreta with or without straw are collected and anaerobically digested in a large containment vessel or covered lagoon. Digesters are designed and operated for waste stabilization by the microbial reduction of complex organic compounds to CO_2 and CH_4, which is captured and flared or used as a fuel.
Burned for fuel	The dung and urine are excreted on fields. The sun dried dung cakes are burned for fuel.
Cattle and Swine deep bedding	As manure accumulates, bedding is continually added to absorb moisture over a production cycle and possibly for as long as 6 to 12 months. This manure management system also is known as a bedded pack manure management system and may be combined with a dry lot or pasture.
Composting - invessel	Composting, typically in an enclosed channel, with forced aeration and continuous mixing.
Composting - Static pile	Composting in piles with forced aeration but no mixing.
Composting - Intensive windrow	Composting in windrows with regular (at least daily) turning for mixing and aeration.
Composting - Passive windrow	Composting in windrows with infrequent turning for mixing and aeration.
Poultry manure with litter	Similar to cattle and swine deep bedding except usually not combined with a dry lot or pasture. Typically used for all poultry breeder flocks and for the production of meat type chickens (broilers) and other fowl.
Poultry manure without litter	May be similar to open pits in enclosed animal confinement facilities or may be designed and operated to dry the manure as it accumulates. The latter is known as a high-rise manure management system and is a form of passive windrow composting when designed and operated properly.
Aerobic treatment	The biological oxidation of manure collected as a liquid with either forced or natural aeration. Natural aeration is limited to aerobic and facultative ponds and wetland systems and is due primarily to photosynthesis. Hence, these systems typically become anoxic during periods without sunlight.
Covered anerobic lagoon	The cover is generally constructed of a high-density polyethylene (HDPE), which joins up with the lagoon lining..

3.A Livestock

The *Software* allows to calculate livestock emissions according to three methodological approaches:

- ✓ IPCC Default (Tier 1) for every livestock population, based on activity data by emission factor
- ✓ IPCC Tier 2 (IPCC Tier 2 – Simplified) for every livestock population, based on dry matter intake;
- ✓ IPCC Tier 2 (IPCC Tier 2 – Detailed) for cattle/buffalo and sheep only, based on gross energy need[21];

Once entered data required in **Livestock Manager**, **second step** to calculate emissions from livestock is the compilation of information in **Livestock Population** worksheets for both **3.A.1 - Enteric Fermentation – CH_4** and **3.A.2 – Manure Management** and indirectly for category **3.C.6 - Indirect N2O emissions from Manure Management**.



[21] an energy model, which uses energy components of diet and livestock performance parameters (e.g. weight gain, milk yields, activity, etc.)

3.A Livestock Population (3.A.1 & 3.A.2)

Allows to select the tier level and to input annual average population data for each animal subdivision. In addition, where one of the two IPCC Tier 2 levels (*Detailed* or *Simplified*) is selected, the worksheet allows to input all parameters used to estimate average daily gross energy intake.

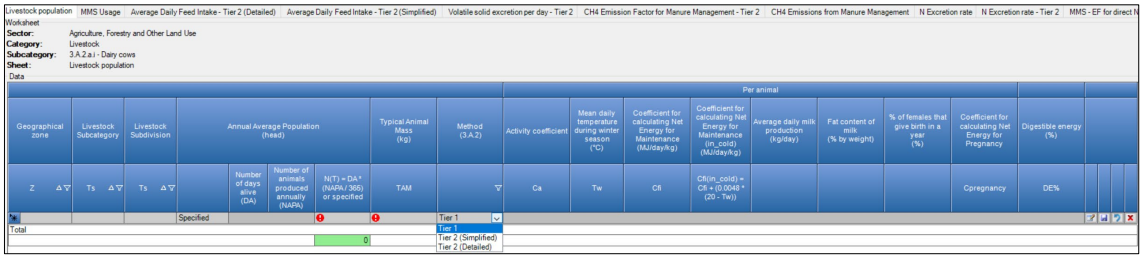
Guidance on data collection and analysis for livestock population characterisation is provided in Section 10.2.

Note: Information input in **Livestock Population** worksheet of category 3.A.1 (*Enteric Fermentation*) are automatically transferred in **Livestock Population** worksheet of category 3.A.2 (*Manure Management*) and vice versa.

Calculation worksheet **Livestock Population** requires users to select the *methodological tier level* to be applied to the relevant livestock population and to enter the *annual average population* and the *typical animal mass* of such population. Depending on the livestock population and associated methodological tier level selected users enter required parameters to calculate the daily gross energy intake.

Methodological tier level selection is operated in Column |Method| by selecting the desired methodological tier level from the dropdown menu:

selecting the methodological tier level (example from *Dairy Cows* livestock category)



In particular:

All livestock species all methodological tier levels

IPCC Tier 1 (IPCC Default)

1. Column |Z|: Select *Geographical zone* from dropdown menu[22];
2. Column |Tsc|: Select *Livestock Subcategory* from dropdown menu[23]. If no subcategory has been entered in **Livestock Characterisation** TAB of the relevant animal species, select *Unspecified*;
3. Column |Tsd|: Select *Livestock Subdivision* from dropdown menu[24]. If no subcategory has been entered in **Livestock Characterisation** TAB of the relevant animal species, select *Unspecified*;
4. Column |AAP|: Select either *Specified* or *Calculated* (Eq. 10.1) for *Annual Average Population*[25] *(AAP)*, heads. Thus:
   - *Specified*, enter heads value in Column |N(T)|

	Number of days alive (DA)	Number of animals produced annually (NAPA)	N(T) = DA * (NAPA / 365) or specified
Specified			1000

[22] The dropdown menu contains all *Geographical zones* entered in **Geographical Zones** TAB.
[23] The dropdown menu contains all *subcategories* entered in **Livestock Characterisation** TAB of the relevant animal species.
[24] The dropdown menu contains all *subcategories* entered in **Livestock Characterisation** TAB of the relevant animal species.
[25] Where possible, inventory compilers use population data from official national statistics, including statistics reported by country to the Food and Agriculture Organisation (FAO) and stored in its FAOSTAT.
Seasonal births or slaughters may cause the population size to expand or contract at different times of the year which will require the population numbers to be adjusted accordingly.
E.g. broiler chickens are typically grown approximately 60 days before slaughter. Estimating N(T) as the number of grown and slaughtered over the course of a year would greatly overestimate the population, as it would assume each lived the equivalent of 365 days. Instead, one should estimate the average annual population as the number of animals grown divided by the number of growing cycles per year. For example, if broiler chickens are typically grown in flocks for 60 days, an operation could turn over approximately 6 flocks of chickens over the period of one year. Therefore, if the operation grew 60,000 chickens in a year, their average annual population would be 9,863 chickens. For this example the equation would be: Annual average population = 60 days * 60,000 / 365 days / yr = 9,863 chickens
Further, in a growing or decreasing population most animals are alive for only part of a complete year, although their contribution shall be included in the *Annual Average Population*, regardless of were slaughtered or die of natural causes. Also in this case the application of Equation 10.1 allows to calculate the correct value, in heads, to be entered as *Annual Average Population*.

- *Calculated*:
  a. Column |(DA)|: Enter *Number of days alive* of the relevant **Livestock Subcategory**/**Livestock Subdivision** combination;
  b. Column |(NAPA)|: Enter *Number of animals produced annually* of the relevant **Livestock Subcategory**/**Livestock Subdivision** combination;
  c. Column |N(T)|: *Software* calculates[26] *Annual Average Population* heads

	Number of days alive (DA)	Number of animals produced annually (NAPA)	N(T) = DA * (NAPA / 365) or specified
Eq. 10.1	180	1000	493

5. Column |TAM|: Select *Typical Animal Mass* from dropdown menu or enter a user-specific value, kg per head. It may be used at IPCC Tier 1 to scale EFs[27].

All livestock species with IPCC Tier 2 (Simplified) methodological level

All steps described for IPCC Tier 1 (IPCC default) applies to IPCC Tier 2 (Simplified), and in addition:

6. Column |DE%|: Select *Digestible energy* from dropdown menu or enter a user-specific value, percentage[28].

[26] Calculation of the *AAP* applies also to populations that stay within a subcategory/subdivision for a portion of the year only while moving to other subcategory(ies)/subdivision(s) for the remaining portion. For instance, a population of X heads of *Mature Ewe* spends 4 months in highland rangeland and the rest of the year in lowland pastures. So, the population can be split in 2 subpopulations, e.g. *Rangeland* vs *Pasture*, and the *AAP* for the 2 subpopulation calculates as $\frac{X}{120}$ and $\frac{X}{245}$ respectively. Where one of the two phases occurs outside of the geographical boundaries of the inventory -e.g. the lowland pasture is in another country- reporting will be limited to the subpopulation within the geographical boundaries of the inventory -e.g. the highland rangeland-.

[27] Page 10.24 - One approach for developing an approximate emission factor is to use the IPCC Default CH_4 emissions factor for Enteric Fermentation from an animal with a similar digestive system and to scale it using the ratio of the weights of the animals raised to the 0.75 power.

[28] *Feed digestibility* (DE%) - Table 10.2 - is the portion of gross energy (GE) in the feed not excreted in the faeces, and it has to be expressed as the percentage (%) of GE or DMI

Example of data input, a user has four geographical zones: *Rangeland*, *Intensive Livestock farming*, *Rural Livestock farming*, *Coastal prairies*, with the following livestock populations and associated MMSs to which the following Methodological Tiers apply:

Geographical Zone	Category	Subcategory	Subdivision	MMS	Tier
Rangeland *Coastal prairies*	**Dairy Cows**	**Dairy Cows**	*Grigia*	Pasture/Range/Paddock *Dairy cows*: Daily spread	IPPC Default
	Other Cattle	**Other Cattle**	*Chianina*		
			Grigia		
	Sheep	**Mature Ewes**	Breeding Ewes		IPCC Tier 2 (Detailed)
			Milking Ewes		
		Growing Lambs	Intact Males		IPCC Tier 2 (Simplified)
			Castrates		
			Females		
		Other Mature Sheep	NA		IPPC Default
Intensive Livestock farming	**Dairy Cows**	**Mature Dairy Cows**	High-producing cows	Uncovered anaerobic lagoon	IPCC Tier 2 (Detailed)
	Other Cattle	**Growing Cattle**	Feedlot-fed Cattle (>90% concentrate)	Pit storage	
			Calves pre-weaning		
			Growing/Fattening post-weaning		
			Replacement dairy heifers		
		Other Mature Cattle	Cows to produce offspring for meat	Solid storage	
			Bulls for breeding		
	Swine	**Mature Swine**	Sows in gestation	Covered anaerobic lagoon Uncovered anaerobic lagoon	IPCC Tier 2 (Simplified)
			Sows nursing		
			Boars for breeding		
		Growing Swine	Nursery		
			Finishing		
			Gilts		
			Growing Boars		
Rural Livestock farming	**Dairy Cows**	**Mature Dairy Cows**	Low-producing cows	Deep Bedding	IPCC Tier 2 (Simplified)
	Other Cattle	**Growing Cattle**	Feedlot-fed Cattle (>90% concentrate)	Dry lot	
			Calves pre-weaning		
			Growing/Fattening post-weaning		
			Replacement dairy heifers		
		Other Mature Cattle	Cows to produce offspring for meat	Composting – passive windrow	
			Multipurpose cows		
			Bulls for breeding		
			Bullocks for draft power		
	Swine	NA	NA	Liquid slurry	IPPC Default

While for different livestock species with IPCC Tier 2 methodological level

- **Dairy Cows** (3.A.1.a.i & 3.A.2.a.i) livestock population has three alternative methodological tiers: *IPCC Default (Tier 1)*, *Tier 2 (Simplified)*[29], *Tier 2 (Detailed)*[30].

  limited to category 3.A.2.a.i, once *Tier 2 (Simplified) Method* has been selected data are entered as follows:

  All steps described for IPCC Default (Tier 1) and IPCC Tier 2 (Simplified) for all livestock species apply to IPCC Tier 2 (Simplified) for Dairy Cows, and in addition:

  7. Column |Milk|: Select *Average daily milk production* from dropdown menu or enter a user-specific value, kg day^{-1};
  8. Column |Fat|: Select *Fat content of milk* from dropdown menu or enter a user-specific value, %;

  for both categories 3.A.1.a.i & **3.A.2.a.i**, once *Tier 2 (Detailed) Method* has been selected data are entered as follows:

  All steps described for IPCC Default (Tier 1) and IPCC Tier 2 (Simplified) for all livestock species as well as for IPCC Tier 2 (Simplified) for Dairy Cows apply to IPCC Tier 2 (Detailed), and in addition:

  9. Column |Ca|: Select *Activity coefficient* from dropdown menu or enter a user-specific value, dimensionless[31];
  10. Column |Tw|: This step applies only to open-lot fed cattle in colder climates for which Cfi[32] is calculated applying Equation 10.2. Enter *Mean daily temperature in winter season*, °C, and the *Software* calculate the *Coefficient for NEm(in_cold)* for open-lot fed cattle in colder climates in Column |Cfi(in_cold)|;
  11. Column |Cfi|: Select *Coefficient to calculate Net Energy for maintenance* from dropdown menu or enter a user-specific value, dimensionless[33];
  12. Column |%|: Select *Percentage of female that give birth in a year* from dropdown menu or enter a user-specific value, %;
  13. Column |Cpregnancy|: Select *Coefficient to calculate Net Energy for pregnancy* from dropdown menu or enter a user-specific value, dimensionless[34];

- **Other Cattle** (3.A.1.a.ii & 3.A.2.a.ii) and **Buffalo** (3.A.1.b & 3.A.2.b) livestock population has three alternative methodological tiers: *IPCC Default (Tier 1)*, *Tier 2 (Simplified)*[35], *Tier 2 (Detailed)*[36].

  limited to category 3.A.2.a.ii, once *Tier 2 (Simplified) Method* has been selected data are entered as follows:

  All steps described for IPCC Default (Tier 1) and IPCC Tier 2 (Simplified) for all livestock species apply to IPCC Tier 2 (Simplified) for Other Cattle, and in addition:

  7. Column |WG|: This step applies only to growing cattle. Enter *Average weight gain per day* value[37], kg day^{-1};
  8. Column |Milk|: Select *Average daily milk production* from dropdown menu or enter a user-specific value, kg day^{-1};
  9. Column |Fat|: Select *Fat content of milk* from dropdown menu or enter a user-specific value, %;

  for both categories 3.A.1.a.ii & **3.A.2.a.ii**, once *Tier 2 (Detailed) Method* has been selected data are entered as follows:

  All steps described for IPCC Default (Tier 1) and IPCC Tier 2 (Simplified) as well as for IPCC Tier 2 (Simplified) for Other Cattle apply to IPCC Tier 2 (Detailed), and in addition:

  10. Column |WG|: This step applies only to growing cattle. Enter *Average weight gain per day* value[38], kg day^{-1};
  11. Column |C|: This step applies only to growing cattle. Select *Coefficient to calculate Net Energy for growth* from dropdown menu or enter a user-specific value, dimensionless;
  12. Column |MW|: This step applies only to growing cattle. Enter *Mature weight* value[39], kg;

[29] Based on the dry matter intake (DMI).
[30] Based on the dry matter intake (DMI).
[31] A value between 0 and 1 - Table 10.5
[32] Coefficient to calculate Net Energy for maintenance (NEm)
[33] A value between 0 and 1
[34] A value between 0 and 1
[35] Based on the dry matter intake (DMI).
[36] Based on the dry matter intake (DMI).
[37] *2006 IPCC Guidelines* contain values in Table 10A.2
[38] *2006 IPCC Guidelines* contain values in Table 10A.2
[39] *2006 IPCC Guidelines* contain values in Table 10A.2

Note that: that it refers to the body weight of the subcategory/subdivision in moderate body condition at maturity or the target weight related to stage of growth[40]*)*

13. Column |Hours: This step applies only to draft bullock. Enter *Average number of hours worked per day* value[41], kg;
14. Column |Ca|: Select *Activity coefficient* from dropdown menu or enter a user-specific value, dimensionless[42];
15. Column |Tw|: This step applies only to open-lot fed cattle in colder climates for which Cfi[43] is calculated applying Equation 10.2. Enter *Mean daily temperature in winter season*, °C, and the *Software* calculate the *Coefficient for NEm(in_cold)* for open-lot fed cattle in colder climates in Column |Cfi(in_cold)|;
16. Column |Tw|: This step applies only to open-lot fed cattle in colder climates for which Cfi[44] is calculated applying Equation 10.2. Enter *Mean daily temperature in winter season*, °C, and the *Software* calculate the *Coefficient for NEm(in_cold)* for open-lot fed cattle in colder climates in Column |Cfi(in_cold)|;
17. Column |Cfi|: Select *Coefficient to calculate Net Energy for maintenance* from dropdown menu or enter a user-specific value, dimensionless[45];
18. Column |Milk|: This step applies only to cow that are in lactation period. Select *Average daily milk production* from dropdown menu or enter a user-specific value, kg day^{-1};
19. Column |Fat|: This step applies only to cow that are in lactation period. Select *Fat content of milk* from dropdown menu or enter a user-specific value, %;
20. Column |%|: This step applies only to cow. Select *Percentage of female that give birth in a year* from dropdown menu or enter a user-specific value, %;
21. Column |Cpregnancy|: This step applies only to cow. Select *Coefficient to calculate Net Energy for pregnancy* from dropdown menu or enter a user-specific value, dimensionless[46];

[40] Since statistical offices may collect and report data on highly disaggregated population (e.g., bovines less than one year old or bovines aged under 8 months, cattle aged between one and two years old), hence, this parameter (i.e., mature weight) refer to target weight related to stage of growth. Herewith, the number of days needed for animals to reach from the beginning of growing stage to target weight of this growing stage should be taken into consideration to calculate the daily weight gain.

[41] *2006 IPCC Guidelines* contain values in Table 10A.2. It is calculated as the total number of hours worked by the population during its *number of days alive* (usually the entire year) divided by the number od days alive (usually 365).

[42] A value between 0 and 1 - Table 10.5

[43] Coefficient to calculate Net Energy for maintenance (NEm)

[44] Coefficient to calculate Net Energy for maintenance (NEm)

[45] A value between 0 and 1 - Table 10.4

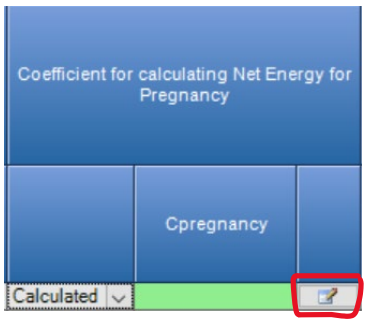
[46] A value between 0 and 1 - Table 10.7

- **Sheep** (3.A.1.c & 3.A.2.c) livestock population has three alternative methodological tiers: *Tier 1*, *Tier 2 (Simplified)*[47], *Tier 2 (Detailed)*[48].

  Once *Tier 2 (Detailed) Method* has been selected data are entered as follows:

  All steps described for IPCC default (Tier 1) and IPCC Tier 2 (Simplified) for all livestock species applies to IPCC Tier 2 (Detailed), and in addition:

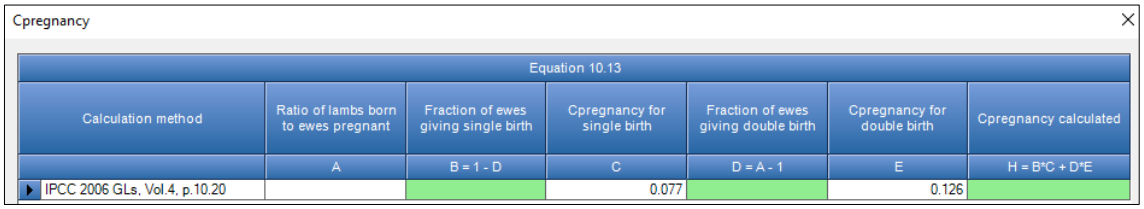
  7. Column |BWi|: This step applies only to growing lamb. Enter *Alive bodyweight at weaning* value, kg;
  8. Column |BMf|: This step applies only to growing lamb. Enter *Alive bodyweight at 1 year or at slaughtering*[49] value, kg;
  9. Column |WGwean|: This step applies only to growing lamb. Enter *Total weight gain between birth and weaning* value, kg;
  10. Column |a|: This step applies only to growing lamb. Select *Coefficient a to calculate Net Energy for growth* from dropdown menu or enter a user-specific value, dimensionless;
  11. Column |b|: This step applies only to growing lamb. Select *Coefficient b to calculate Net Energy for growth* from dropdown menu or enter a user-specific value, dimensionless;
  12. Column |Ca|: Select *Activity coefficient* from dropdown menu or enter a user-specific value, dimensionless[50];
  13. Column |Cfi|: Select *Coefficient to calculate Net Energy for maintenance* from dropdown menu or enter a user-specific value, dimensionless[51];
  14. Column |Milk|: This step applies only to milking ewes. Enter *Average daily milk production* value, kg day^{-1};
  15. Column |EVmilk|: This step applies only to milking ewes. Select *Energy required to produce 1 kg of milk* from dropdown menu or enter a user-specific value, MJ kg^{-1};
  16. Column |%|: This step applies only to breeding ewes. Enter *Percentage of female that give birth in a year* value, %;
  17. Column |Cpregnancy|: This step applies only to breeding ewes. Select to either *Specify* or *Calculate* the value, dimensionless[52]. Thus:
      - *Specified*, select *Coefficient to calculate Net Energy for pregnancy* from dropdown menu or enter a user-specific value;
      - *Calculated*, click on the icon on the right-hand side of the column on the calculation icon:



to open a new window where to calculate Cpregnancy, where the first step is to select the calculation method:

[47] Based on the dry matter intake (DMI).
[48] Based on the dry matter intake (DMI).
[49] In case slaughter occurs before 1-year old age.
[50] A value between 0 and 1 - Table 10.5
[51] A value between 0 and 1 - Table 10.4
[52] A value between 0 and 1 - Table 10.7

- Either *with equation at page 10.20*, this method applies only if the number of lambs born in a year divided by the number of ewes that are pregnant in a year exceeds 1.0[53] and is less than 2.0. In such a case the following steps apply:

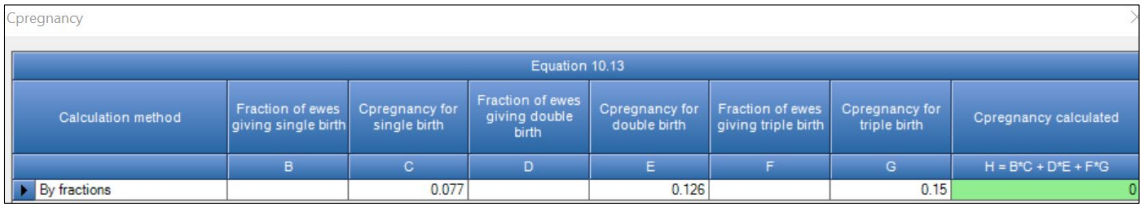


Cpregnancy

Equation 10.13						
Calculation method	Ratio of lambs born to ewes pregnant	Fraction of ewes giving single birth	Cpregnancy for single birth	Fraction of ewes giving double birth	Cpregnancy for double birth	Cpregnancy calculated
	A	B = 1 - D	C	D = A - 1	E	H = B*C + D*E
IPCC 2006 GLs, Vol.4, p.10.20			0.077		0.126	

  a. Column |B|: Enter the ratio lambs born to ewes that gave birth $\frac{total\ lamb}{total\ ewes\ that\ gave\ birth}$, dimensionless[54];
  b. Column |C|: Keep the IPCC default or enter the user-specific value, dimensionless[55];
  c. Column |C|: Keep the IPCC default or enter the user-specific value, dimensionless[56];

- or *by fractions*, and in such a case the following steps apply



Cpregnancy

Equation 10.13							
Calculation method	Fraction of ewes giving single birth	Cpregnancy for single birth	Fraction of ewes giving double birth	Cpregnancy for double birth	Fraction of ewes giving triple birth	Cpregnancy for triple birth	Cpregnancy calculated
	B	C	D	E	F	G	H = B*C + D*E + F*G
By fractions		0.077		0.126		0.15	0

  a. Column |B|: Enter the fraction of ewes that gives a single birth calculated as $\frac{ewes\ that\ give\ birth\ to\ a\ single}{total\ ewes\ that\ gave\ birth}$, dimensionless[57];
  b. Column |C|: Keep the IPCC default or enter the user-specific value, dimensionless[58];
  c. Column |D|: Enter the fraction of ewes that gives a double birth (twins) calculated as $\frac{ewes\ that\ give\ birth\ to\ twins}{total\ ewes\ that\ gave\ birth}$, dimensionless[59];
  d. Column |E|: Keep the IPCC default or enter the user-specific value, dimensionless[60];
  e. Column |F|: Enter the fraction of ewes that gives a triple birth (triplet) calculated as $\frac{ewes\ that\ give\ birth\ to\ triplet}{total\ ewes\ that\ gave\ birth}$, dimensionless[61];

18. Column |Wool|: This step applies only to ewes. Enter *Average Annual Wool Production per head* value, kg yr^{-1};
19. Column |EVwool|: This step applies only to ewes. Select *Energy required to produce 1 kg of wool* from dropdown menu or enter a user-specific value, MJ kg^{-1};

[53] If the number of lambs born in a year divided by the number of ewes that are pregnant in a year is less than or equal to 1.0, then the coefficient for single births can be used.
[54] A value between >1 and 2
[55] A value between 0 and 1
[56] A value between 0 and 1
[57] A value between 0 and 1
[58] A value between 0 and 1
[59] A value between 0 and 1
[60] A value between 0 and 1
[61] A value between 0 and 1

TIP

Data to be entered for variables that require a daily value, namely:

- ✓ *Average daily milk production,*
- ✓ *Average weight gain per day,*
- ✓ *Average number of hours worked per day*

need to elaborated according to the population characterization entered. For instance:

I. let's make the cases of two alternative characterisation of Mature Ewe (sheep) population:
   a. the population is reported within a single subcategory/subdivision -i.e. a single row in **Livestock Population** worksheet-, in this case the *Annual Average Population* is entered (*Specified*) in Column |AAP| and the value to be entered in Column |Milk| is calculated as the total milk produced[62] by the ewe during its lactating period [63] divided by the number of days in a year (365); or $\frac{daily\ milk\ production\ (kg\ day^{-1}) * lactating\ period\ (days)}{365}$
   b. the population is reported in 2 subdivisions, *Ewe at breeding* and *Ewe at lactating* -i.e. two rows in **Livestock Population** worksheet-, in this case the *Annual Average Population* is calculated by the sofwtare on the basis of the number of days the Mature Ewe is in a such functional subdivision (*Calculated*) in Column |AAP| and the value to be entered in Column |Milk| is indeed the average milk production during the lactating period; or $\frac{total\ milk\ production\ (kg)}{lactating\ period\ (days)}$

II. let's make the cases of two alternative characterisation of Growing cow population:
   a. the population is reported within a single subcategory/subdivision -i.e. a single row in **Livestock Population** worksheet-, in this case the *Average weight gain per day* to be entered is the total weight gain across the year divided by the number of days in a year (365); or $\frac{total\ weight\ gain\ in\ a\ year\ (kg)}{365}$
   b. the population is reported in 3 subdivisions, *Calf (between 0 to 6 months)*, *Heifer (between 6 to 12 months)*, *yearling (between 1 to 2 years)*, -i.e. three rows in **Livestock Population** worksheet-, in this case for each subdivision the *Average weight gain per day* to be entered is the total weight gain across the period in which the animal is in the subdivision divided by the number of days of the growing period; e.g. for *Calf* $\frac{total\ weight\ gain\ from\ 0\ to\ 6\ months\ (kg)}{183}$

Similarly, data to be entered for variables that require a percent value, namely

- ✓ *Percentage of female that give birth in a year*

need to elaborated according to the population characterisation entered. For instance, let's make the cases of two alternative characterisation of Mature Ewe (sheep) population:

   a. the population is reported within a single subcategory/subdivision -i.e. a single row in **Livestock Population** worksheet-, in this case the *Percentage of female that give birth in a year* is entered (*Specified*) in Column |AAP| and the value to be entered in Column |%| is calculated as the total milk produced by the ewe during its lactating period divided by the number of days in a year (365); or $\frac{daily\ milk\ production\ (kg\ day^{-1}) * lactating\ period\ (days)}{365}$
   b. the population is reported in 2 subdivisions, *Ewe at breeding* and *Ewe at lactating* -i.e. two rows in **Livestock Population** worksheet-, in this case the *Annual Average Population* is calculated by the sofwtare on the basis of the number of days the Mature Ewe is in a such functional subdivision (*Calculated*) in Column |AAP| and the value to be entered in Column |Milk| is indeed the average milk production during the lactating period; or $\frac{total\ milk\ production\ (kg)}{lactating\ period\ (days)}$

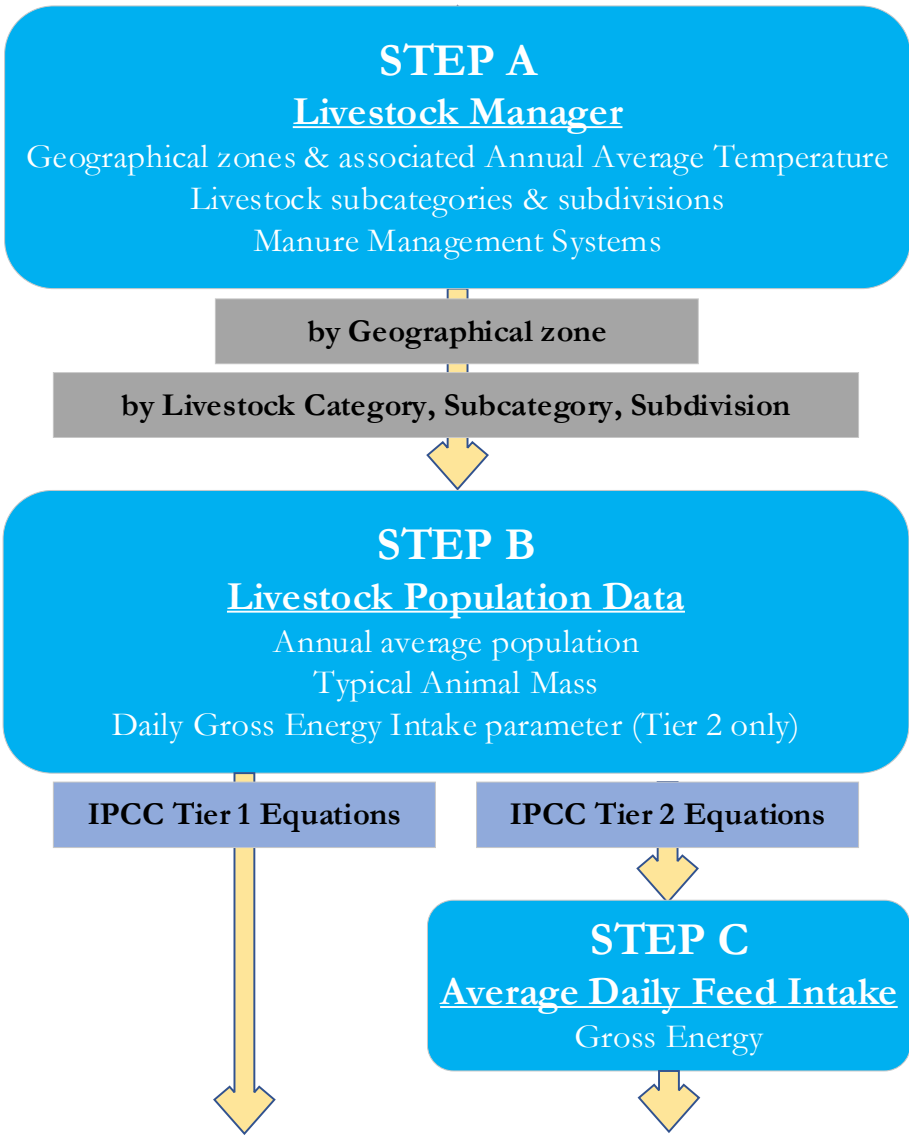
Recall:

press the floppy disk icon on the right-hand side of the worksheet to ensure that information entered in the row is saved in the database.

[62] This can be calculated as the daily production during the lactating period multiplied by the length (i.e. days) of the lactating period
[63] Meat and wool breeds of sheep lactate for a shorter lactating period (e.g. 90–150 days) than dairy breeds (e.g. 120–240 days)

3.A Average Daily Feed Intake (3.A.1 & 3.A.2)

For IPCC Tier 2 methods, once entered data on **Livestock Population** next step is to enter information to calculate the **Average Daily Feed Intake**.



The average daily feed intake can be calculated either from the dry matter intake (*Simplified* approach - Equations 10.17/18a/18b for Cattle, generic equation -Feed Intake by Energy density of Feed- for all other livestock species) or calculating the daily energy need (*Detailed* approach - Equations at Table 10.3).

In the *2006 IPCC Guidelines* the *Detailed* approach is provided for cattle, buffalo and sheep only, given these were the largest sources of GHG emissions from livestock.

Note: This step does not apply to IPCC Tier 1 method.

3.A Average Daily Feed Intake (3.A.1 & 3.A.2) - IPCC Tier 2 (Simplified)

This worksheet is available for each and every livestock species, including those entered by users. It applies to those livestock subcategories/subdivisions for which *Tier 2 (Simplified)* methodology has been selected in **Livestock Population** worksheet.

Note: Information input in **Average Daily Feed Intake** worksheet of category 3.A.1 (*Enteric Fermentation*) are automatically transferred in **Average Daily Feed Intake** worksheet of category 3.A.2 (*Manure Management*) and vice versa.

Depending on the livestock population, information is entered as follows:

Dairy Cows

1. Column |GE|: Select to either *Specify* or *Calculate* Gross Energy value, MJ day^{-1}. Thus:
   - *Specified*, enter a user-specific value, and no further steps needed.
   - *Calculated*, *Software* calculates it on the basis of information input in:
2. Column |DMI|: Select to either *Specify* or *Calculate* Feed Intake value, kg DM day^{-1}. Thus:
   - *Specified*, enter a user-specific value;
   - *Calculated*, *Software* calculates it on the basis of information input in **Livestock Population** worksheet by applying the following equations:
     - ✓ Growing and finishing Cattle - Equation 10.17
     - ✓ Mature Beef Cattle - Equation 10.18a
     - ✓ Mature Dairy Cattle - Equation 10.18b
3. Column |FED|: Select *Energy density of feed* from dropdown menu or enter a user-specific value, MJ (kg DM day)$^{-1}$;

Other Cattle

1. Column |GE|: Select to either *Specify* or *Calculate* Gross Energy value, MJ day^{-1}. Thus:
   - *Specified*, enter a user-specific value, and no further steps needed.
   - *Calculated*, *Software* calculates it on the basis of information input in:
2. Column |NEma|: Select *dietary net energy concentration* from dropdown menu or enter a user-specific value, MJ kg DM^{-1};
3. Column |DMI|: Select to either *Specify* or *Calculate* Feed Intake value, kg DM day^{-1}. Thus:
   - *Specified*, enter a user-specific value;
   - *Calculated*, *Software* calculates it on the basis of information input in **Livestock Population** worksheet
4. Column |FED|: Select *Energy density of feed* from dropdown menu or enter a user-specific value, MJ (kg DM day)$^{-1}$;

Other livestock

1. Column |GE|: Select to either *Specify* or *Calculate* Gross Energy value, MJ day^{-1}. Thus:
   - *Specified*, enter a user-specific value, and no any further steps needed.
   - *Calculated*, *Software* calculates it on the basis of information input in:
2. Column |DMI|: enter *Feed Intake* user-specific value, kg DM day^{-1}.
3. Column |FED|: Select *Energy density of feed* from dropdown menu or enter a user-specific value, MJ (kg DM day)$^{-1}$;

Recall:

press the floppy disk icon on the right-hand side of the worksheet to ensure that information entered in the row is saved in the database.

3.A Average Daily Feed Intake (3.A.1 & 3.A.2) - IPCC Tier 2 (Detailed)

This worksheet is available for four livestock populations only: *Dairy Cows*, *Other Cattle*, *Buffalo*, *Sheep*. It applies to those subcategories/subdivisions for which *Tier 2 (Detailed)* methodology has been selected in **Livestock Population** worksheet.

Note: Information input in **Average Daily Feed Intake** worksheet of category 3.A.1 (*Enteric Fermentation*) are automatically transferred in **Average Daily Feed Intake** worksheet of category 3.A.2 (*Manure Management*) and vice versa.

Depending on the livestock population, information is entered as follows:

Dairy Cows/Other Cattle/Buffalo

1. Column |NEm|: Select *Cfi* parameter from dropdown menu -i.e. *Cfi* or *Cfi(in_cold)*-, MJ day^{-1}.

The *Software* calculates all other parameters as well as *Gross Energy*, MJ day^{-1}

Sheep

No data enter needed, the *Software* calculates all parameters as well as *Gross Energy*, MJ day^{-1}

Recall:

press the floppy disk icon on the right-hand side of the worksheet to ensure that information entered in the row is saved in the database.

3.A.1 Enteric Fermentation - CH_4

Information

Methane is produced in herbivores (mostly ruminants) as a by-product of enteric fermentation and is released into the atmosphere through belching (**Table 1**).

GHGs

Enteric Fermentation source category emits the following GHGs:

CO_2		CH_4	N_2O	HFCs	PFCs	SF_6	NF_3
		X					

IPCC Equations

- ✓ IPCC Default (Tier 1): Equation 10.19
- ✓ IPCC Tier 2 Simplified: Equations 10.19 and 10.21, *additional species-specific equations 10.17-10.18(a./b.)*
- ✓ IPCC Tier 2 Detailed: Equations 10.19 and 10.21, *additional species-specific equations 10.2 - .16*

As explained in section **II.1.1 - Use of multiple tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement IPCC Tier 1 equation.

Software Worksheets

The *Software* calculates CH_4 emissions using worksheets:

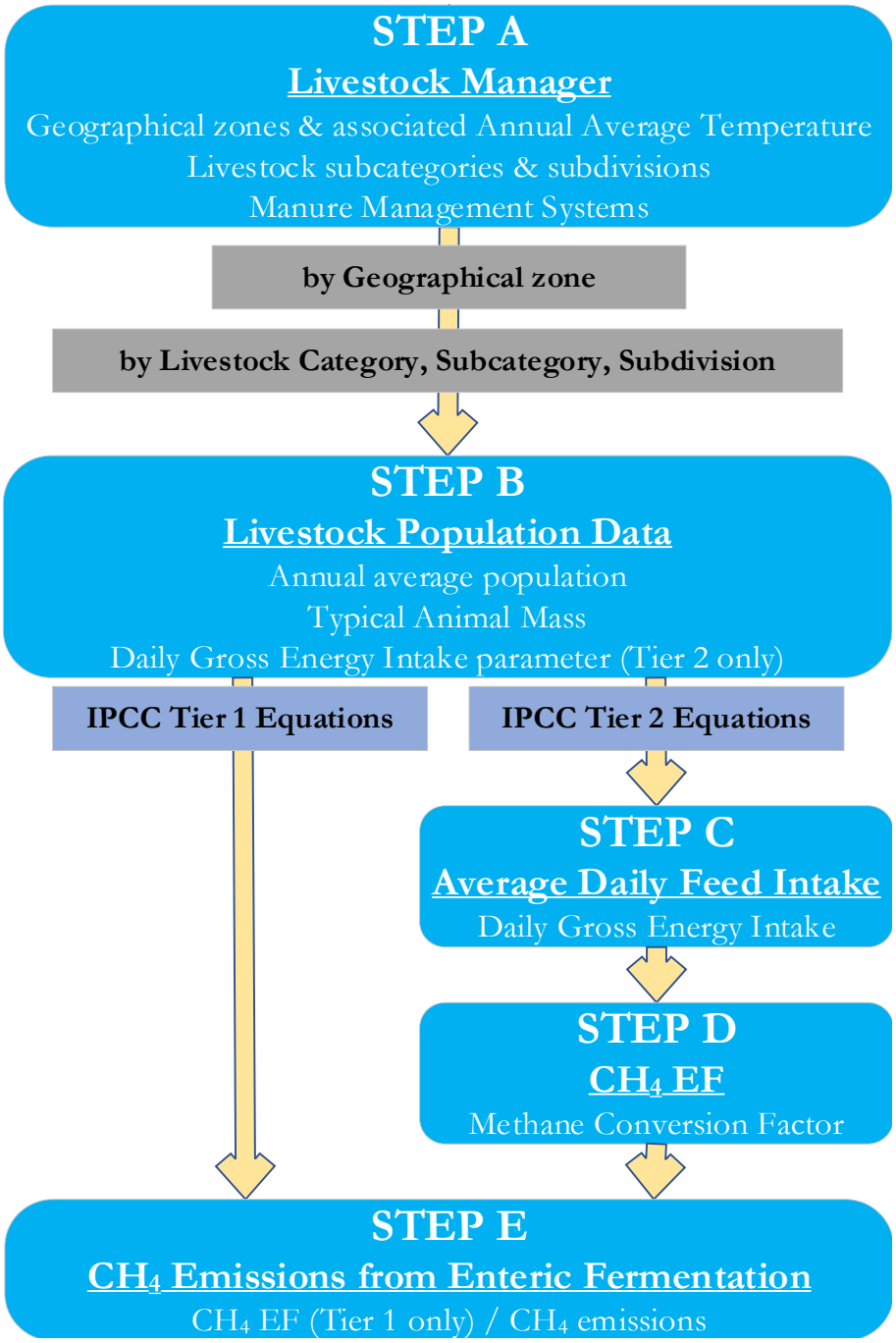
- ✓ **Livestock Manager**: contains data on stratification of the livestock population by geographical boundaries, species, subcategories, subdivisions, as well as on manure management systems utilized in the NGHGI.
- ✓ **Livestock Population**: contains for each subcategory/subdivision combination, the amount of the population and the typical animal mass, as well as a number of parameters for IPCC Tier 2 methodology to calculate the energy needs of animals.
- ✓ **Average Daily Feed Intake**: depending on the methodological tier selected calculates energy needs for each subcategory/subdivision combination.
- ✓ **CH_4 EF – Tier 2**: depending on the methodological tier selected calculates for each subcategory/subdivision combination the EF on the basis of methane conversion factor (MCF)[64].
- ✓ **CH_4 Emissions from Enteric Fermentation**: contains EFs, either entered by the user or compiled by the *Software* at IPCC Tier 2, for each subcategory/subdivision combination and calculates CH_4 Emissions, in mass unit (Gg).

[64] percentage of feed energy converted to methane.

User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 10.2 of the *2006 IPCC Guidelines*, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, for each source category, the users apply steps described in the following flowchart:



Step A, Livestock Manager users stratify the animal population by:

- ✓ Defining geographical zone and assigning an average annual temperature;
- ✓ Selecting predefined livestock subcategories and subdivisions from drop-down menu, and/or entering user-specific subcategories and/or subdivisions, and/or, where relevant, adding animal species and associated subcategories/subdivisions;
- ✓ Selecting manure management systems among those listed and/or, where relevant, adding user-specific MMSs.

Thus, for each population stratum – *i.e. livestock category/subcategory/subdivision in each geographical zone*

Step B, worksheet **Livestock population**, enter in each row *Annual Average Population* and *Typical Animal Mass* data as well as information required to calculate daily *gross energy* need according to the selected tier methodology.

Step C, worksheets **Average Daily Feed Intake - Simplified** or **Average Daily Feed Intake - Detailed**, enter in each row additional information needed to calculate *average daily feed intake* of relevant livestock population/subcategory/subdivision. The two approaches differ on how the gross energy intake is calculated, either through an energy balance of performances and activities of the population (as maintenance, growth, activity, pregnancy, production) -i.e. Detailed-, or derived from the daily feed intake and its energy content -i.e. Simplified-.

Step D, worksheet **CH_4 emission factor for Enteric Fermentation - Tier 2**, for each row of data enter associated *methane conversion factor* and the *Software* calculates CH_4 EF from the percent of daily *gross energy* converted to methane.

Step E, worksheet **CH_4 emissions from Enteric Fermentation**, for IPCC Default (Tier 1) estimates only select from dropdown menu the EF or enter a user-specific value, for each row of data *Software* calculates CH_4 emissions. In addition total emissions are calculated in mass units (Gg). In addition, for each GHG, total emissions are calculated.

Activity data input

Guidance on data collection and analysis for livestock population characterisation is provided in Section 10.2.

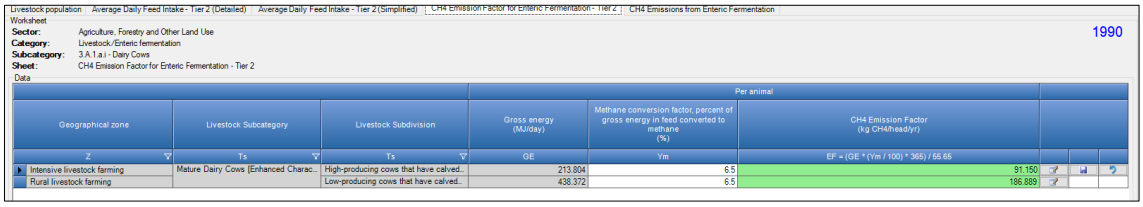
Entering activity data is dealt in worksheet **Livestock Population** and **average daily feed intake**.

Emission factor input

Emission factor can be either entered in worksheet **CH_4 Emissions from Enteric Fermentation** or calculated in worksheet **CH_4 Emission Factor from Enteric Fermentation - Tier 2**.

Worksheet **CH_4 Emission Factor from Enteric Fermentation - Tier 2** is prefilled by the *Software* with a number of rows corresponding to the number of subcategories/subdivision/geographical zone combinations entered in worksheet **Livestock population**. Then, for IPCC Tier 2 methodology only:

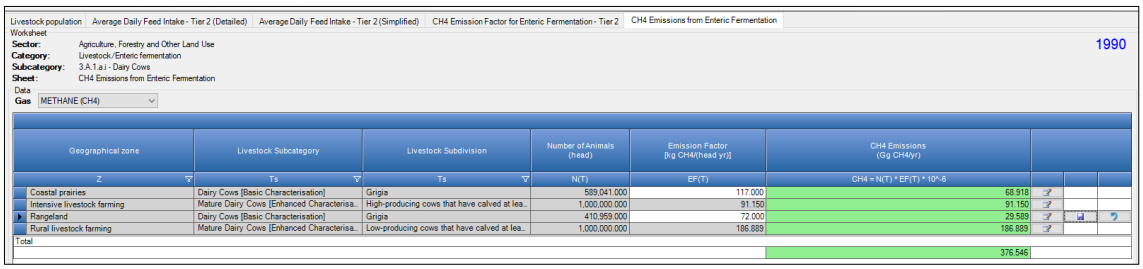
1. Column |Ym|: Select *Ym* from dropdown menu or enter a user-specific value, percentage.



Accordingly, the *Software* calculates *CH_4 Emission Factor*, kg CH_4 $head^{-1}$ yr^{-1}.

Worksheet **CH_4 Emissions from Enteric Fermentation** is prefilled by the *Software* with a number of rows corresponding to the number of subcategories/subdivision/geographical zone combinations entered in worksheet **Livestock population**. Then, for IPCC Default (Tier 1) methodology only:

1. Column |$EF_{(T)}$|: Select $EF_{(T)}$ from dropdown menu or enter a user-specific value, kg CH_4 $head^{-1}$ yr^{-1}.



Recall:

press the floppy disk icon on the right-hand side of the worksheet to ensure that information entered in the row is saved in the database.

Results

Accordingly, the *Software* calculates for each row of data CH_4 Emission, in mass unit (Gg), in worksheet **CH_4 Emissions from Enteric Fermentation**. In addition, total CH_4 emissions are calculated.

3.A.2 Manure Management

Management of manure can generate direct emissions of CH_4 and N_2O as well as indirect emissions of N_2O from volatilisation of NH_3 and NO_X, and N leaching and runoff. Manure includes both dung and urine produced by livestock.

GHGs

Manure Management source category emits the following GHGs:

CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	NF_3
	X	X				

3.A.2 Manure Management – CH_4

Information

The decomposition of manure under anaerobic conditions (i.e., in the absence of oxygen), during storage and treatment, produces CH_4. These conditions occur most readily when large numbers of animals are managed in a confined area (e.g., dairy farms, beef feedlots, and swine and poultry farms), and where manure is disposed of in liquid-based systems.

IPCC Equations

CH_4 emissions are estimated by applying the following IPCC equations:

- ✓ IPCC Default (Tier 1): Equation 10.22
- ✓ IPCC Tier 2 Detailed: Equations 10.22, 10.23, 10.24, *additional species-specific equations 10.2 - .16*
- ✓ IPCC Tier 2 Simplified: Equations 10.22, 10.23, 10.24, *additional species-specific equations 10.17-10.18(a./b.)*

As explained in section **II.1.1 - Use of multiple tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement IPCC Default (Tier 1) equation.

Software Worksheets

The *Software* calculates CH_4 emissions using worksheets:

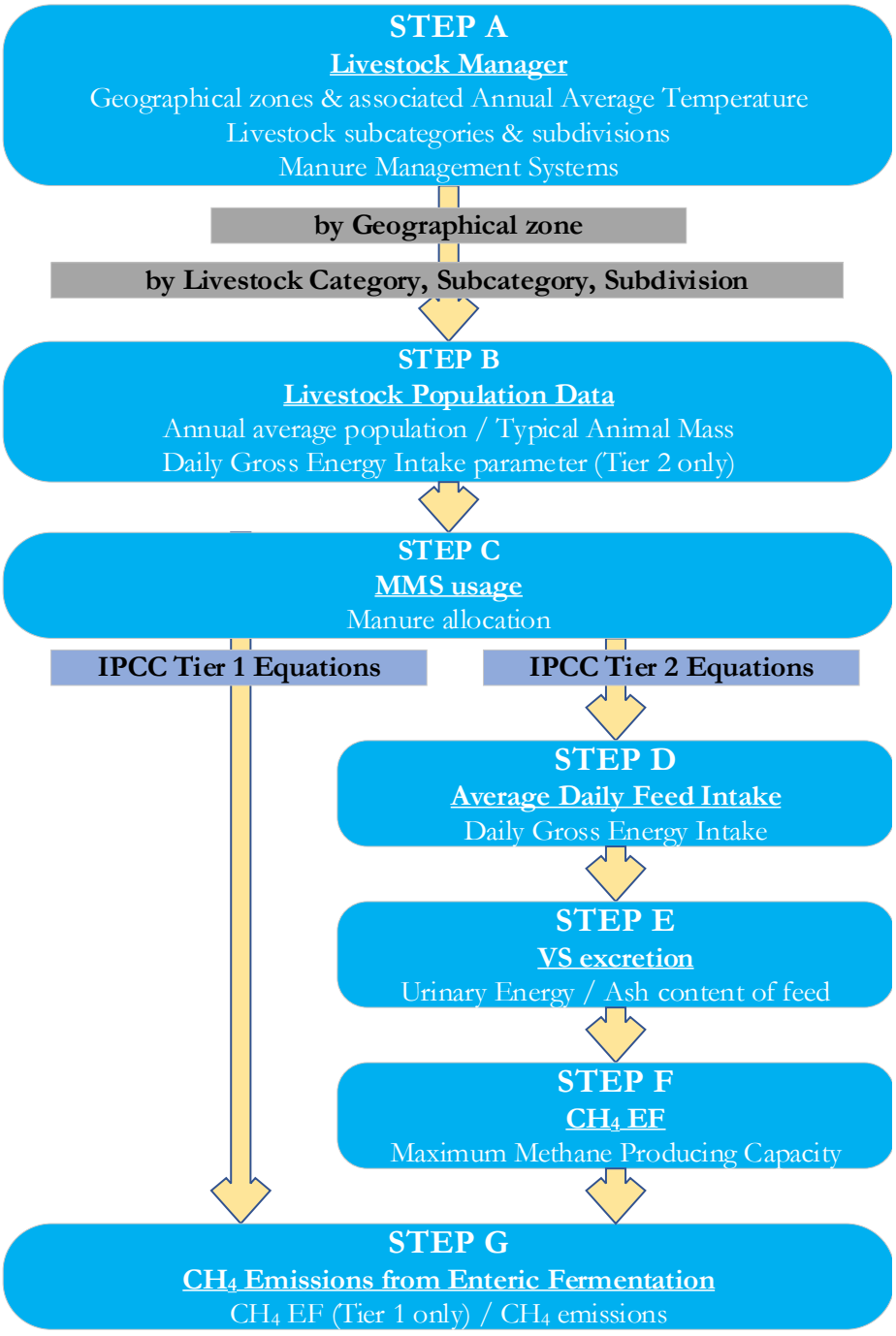
- ✓ **Livestock Manager**: contains data on stratification of the livestock population by geographical boundaries, species, subcategories, subdivisions, as well as on manure management systems utilized in the NGHGI.
- ✓ **Livestock Population**: contains for each subcategory/subdivision combination, the amount of the population and the typical animal mass, as well as a number of parameters for IPCC Tier 2 methodology to calculate the energy needs of animals.
- ✓ **MMS Usage**: contains for each subcategory/subdivision combination, MMSs used and the fraction of manure applied to each MMS.
- ✓ **Average Daily Feed Intake**: depending on the methodological tier selected calculates energy needs for each subcategory/subdivision combination.
- ✓ **VS excretion per day – Tier 2**: depending on the methodological tier selected calculates for each subcategory/subdivision combination the EF on the basis of methane conversion factor (MCF)[65].
- ✓ **CH_4 Emission Factor for Manure Management**: contains for each subcategory/subdivision combination, *maximum methane producing capacity* and the *Volatile solid excretion per day*, based on which the *Software* calculates CH_4 EFs.
- ✓ **CH_4 Emissions from Manure Management**: contains EFs, either entered by the user or compiled by the *Software* at IPCC Tier 2, for each subcategory/subdivision combination and calculates CH_4 Emissions, in mass unit (Gg).

[65] percentage of feed energy converted to methane.

User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 10.3 of the *2006 IPCC Guidelines*, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, for each source category, the users apply steps described in the following flowchart:



Step A, Livestock Manager users stratify the animal population by:

- ✓ Defining geographical zone and assigning an average annual temperature;
- ✓ Selecting predefined livestock subcategories and subdivisions from drop-down menu, and/or entering user-specific subcategories and/or subdivisions, and/or, where relevant, adding animal species and associated subcategories/subdivisions;
- ✓ Selecting manure management systems among those listed and/or, where relevant, adding user-specific MMSs.

Thus, for each population stratum – *i.e. livestock category/subcategory/subdivision in each geographical zone*

Step B, worksheet **Livestock population**, enter in each row *Annual Average Population* and *Typical Animal Mass* data as well as information required to calculate daily *gross energy* need according to the selected tier methodology.

Step C, worksheet **MMS usage**, for each livestock population/subcategory/subdivision allocate manure to management systems.

Step D, worksheets **Average Daily Feed Intake - Simplified** or **Average Daily Feed Intake - Detailed**, enter in each row additional information needed to calculate *average daily feed intake* of relevant livestock population/subcategory/subdivision. The two approaches differ on how the gross energy intake is calculated, either through an energy balance of performances and activities of the population (as maintenance, growth, activity, pregnancy, production) -i.e. Detailed-, or derived from the daily feed intake and its energy content -i.e. Simplified-.

Step E, worksheet **Volatile solid excretion per day - Tier 2**, for each row of data enter associated *urine energy fraction* and *ash content of feed* and the *Software* calculates *Volatile solid excretion per day* from the fraction of the diet consumed that is not digested and thus excreted as fecal material which combined with urinary excretions constitutes manure.

Step F, worksheet **CH_4 emission factor for Manure Management - Tier 2**, for each row of data enter associated *maximum methane producing capacity* and the *Software* calculates CH_4 EF from the *Volatile solid excretion per day* converted to methane.

Step G, worksheet **CH_4 emissions from Manure Management**, for IPCC Tier 1 estimates only select from dropdown menu the EF or enter a user-specific value, for each row of data *Software* calculates CH_4 emissions. In addition total emissions are calculated in mass units (Gg).

Activity data input

Guidance on data collection and analysis for livestock population characterisation is provided in sections 10.2. and 10.4.3

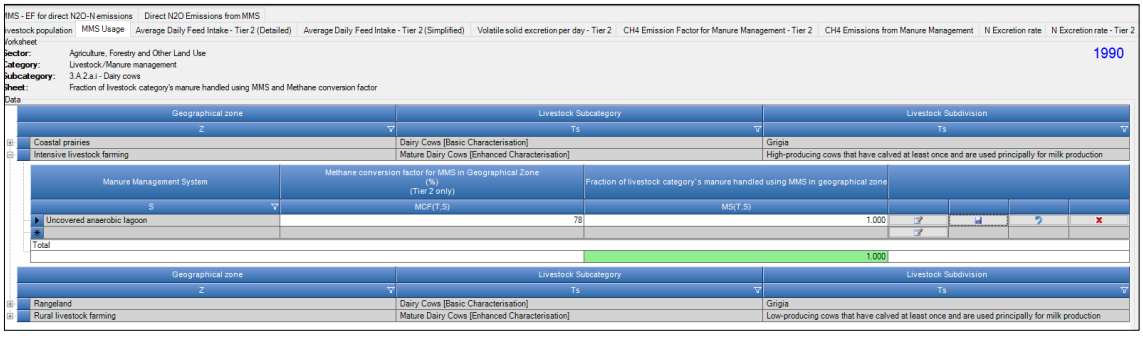
Activity data are **first** entered in worksheets **Livestock Population** and **average daily feed intake**, and **then** in worksheets **MMS usage**.

Worksheet **MMS usage** users click the element ⊞ on the left-hand side of the worksheet to access the sub-tab, then row by row data are entered:

1. Column |S|: Select *Manure Management System* from dropdown menu.
   *Note that only MMS input in the **Livestock Manager** (MMS Tab) are listed in the drop-down menu*
2. Column |$MS_{(T,S)}$|: Enter *fraction of manure handled in the MMS*.
   Note that the total of fractions entered shall sum up to 1 (otherwise the relevant cell for "Total" is coloured in red)

While for IPCC Tier 2 only the following additional information is entered:

3. Column |$MCF_{(T,S)}$|: Select *Methane Conversion Factor* from dropdown menu or enter a user-specific value.

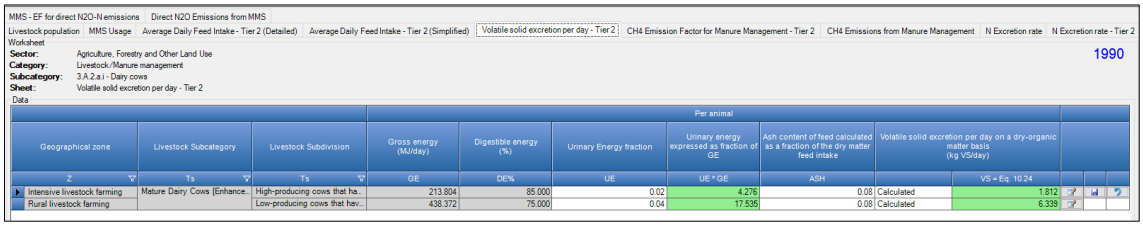


Recall:

press the floppy disk icon on the right-hand side of the worksheet to ensure that information entered in the row is saved in the database.

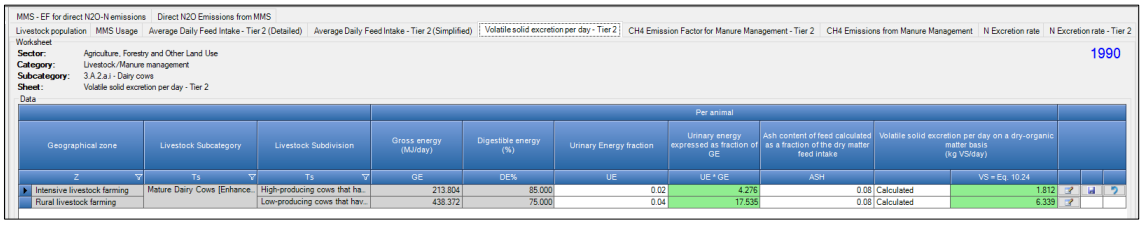
Emission factor input

Emission factor can be either entered in worksheet **CH_4 Emissions from Manure Management** or for IPCC Tier 2 methodology only calculated in worksheet **CH_4 Emission Factor from Manure Management - Tier 2**, to calculate it data are first entered in worksheet **Volatile solid excretion per day – Tier 2**.



Worksheet **Volatile solid excretion per day - Tier 2** is prefilled by the *Software* with a number of rows corresponding to the number of subcategories/subdivision/geographical zone combinations, and associated *digestible energy* value entered in worksheet **Livestock population**, as well as with the corresponding *gross energy* value calculated in worksheet **Average Daily Feed Intake**. Then:

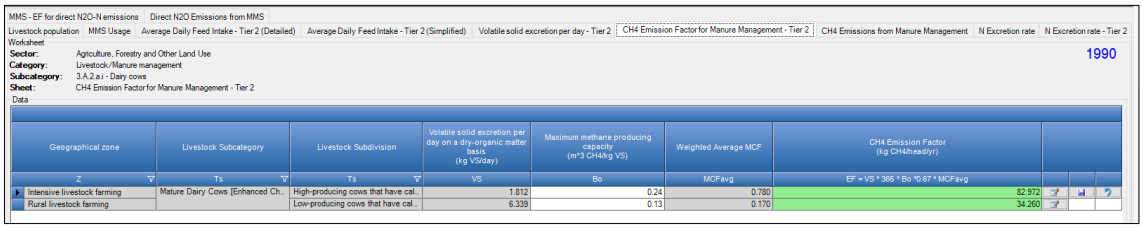
1. Column |UE|: Select *urinary energy* from dropdown menu or enter a user-specific value, fraction;
2. Column |Ash|: Select *ash content of feed* from dropdown menu or enter a user-specific value, fraction;



The *Software* calculates *Volatile solid excretion per day*, kg VS day^{-1}.

Worksheet **CH_4 Emission Factor from Manure Management – Tier 2** is prefilled by the *Software* with a number of rows corresponding to the number of subcategories/subdivision/geographical zone combinations entered in worksheet **Livestock population**, and associated *Volatile solid excretion per day* value calculated in worksheet **Volatile solid excretion per day - Tier 2**, as well as with the corresponding *weighted*[66] *average MCF* value calculated on the basis of MCF values entered in worksheet **MMS usage**. Then:

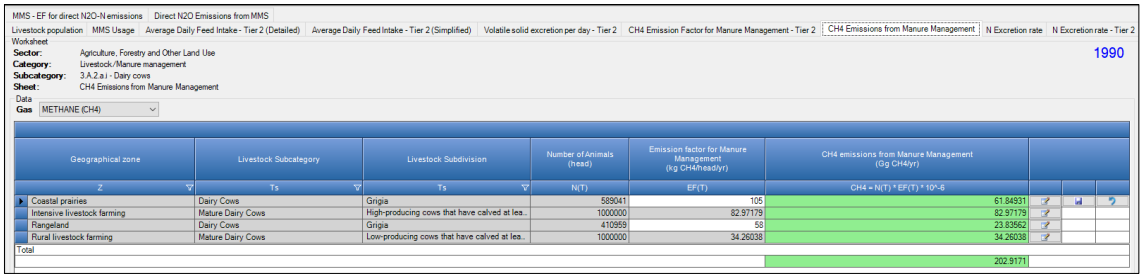
3. Column |B_0|: Select B_0 from dropdown menu or enter a user-specific value, m^3 CH_4 kg VS^{-1}.



The *Software* calculates *CH_4 Emission Factor*, kg CH_4 head^{-1} yr^{-1}.

Worksheet **CH_4 Emissions from Manure Management** is prefilled by the *Software* with a number of rows corresponding to the number of subcategories/subdivision/geographical zone combinations entered in worksheet **Livestock population**. Then, for IPCC Default (Tier 1) methodology only:

4. Column |$EF_{(T)}$|: Select $EF_{(T)}$ from dropdown menu or enter a user-specific value, kg CH_4 head^{-1} yr^{-1}.



[66] Weighted based on fractions of manure allocated to MMSs.

Recall:

press the floppy disk icon on the right-hand side of the worksheet to ensure that information entered in the row is saved in the database.

Results

The *Software* calculates for each row of data CH_4 Emission, in mass unit (Gg), in worksheet **CH_4 Manure Management**. In addition, total CH_4 emissions are calculated.

3.A.2 Manure Management - Direct N_2O

Information

Direct N_2O emissions occur via combined nitrification[67] and denitrification[68] 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 management.

IPCC Equations

Direct N_2O emissions are estimated by applying the following IPCC equations:

- IPCC (Default) Tier 1: Equations 10.25 & 10.30;
- IPCC Tier 2: Equations 10.25 & 10.31, *additional species-specific equations are 10.32-33*.

As explained in section **II.1.1 - Use of multiple tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement IPCC Default (Tier 1) equation.

Software Worksheets

The *Software* calculates Direct N_2O emissions using worksheets:

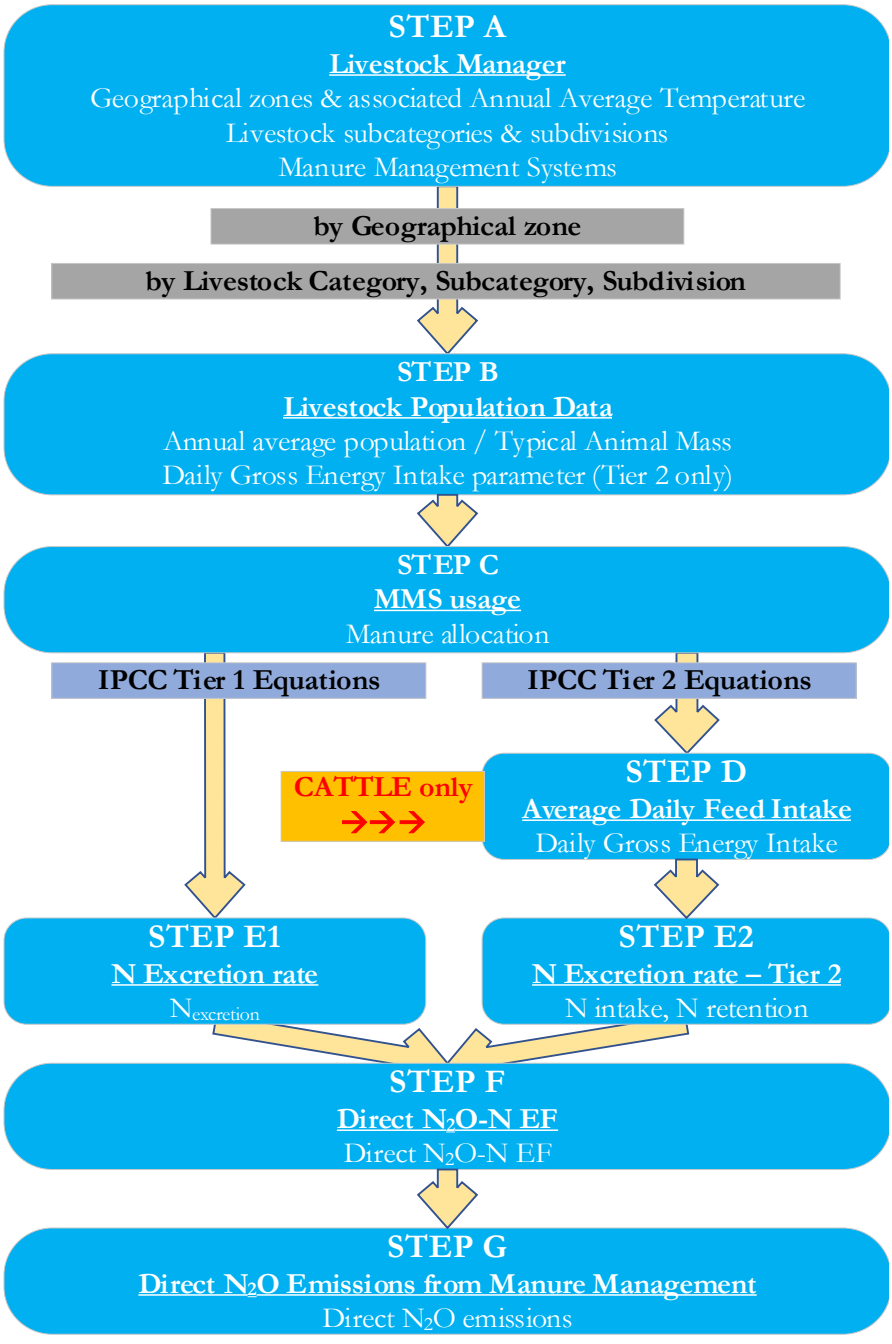
- ✓ **Livestock Manager**: contains data on stratification of the livestock population by geographical boundaries, species, subcategories, subdivisions, as well as on manure management systems utilized in the NGHGI.
- ✓ **Livestock Population**: contains for each subcategory/subdivision combination, the amount of the population and the typical animal mass, as well as a number of parameters for IPCC Tier 2 methodology to calculate the energy needs of animals.
- ✓ **Average Daily Feed Intake**: depending on the methodological tier selected calculates energy needs for each subcategory/subdivision combination.
- ✓ **MMS Usage**: contains for each subcategory/subdivision combination, MMSs used and the fraction of manure applied to each MMS.
- ✓ **N excretion rate**: contains $N_{excretion}$ rate for each subcategory/subdivision combination, where IPCC default method is selected.
- ✓ **N excretion rate - Tier 2**: calculates $N_{excretion}$ rates based on N inputs (percent of crude protein in diet) and N needs for each subcategory/subdivision combination, where IPCC Tier 2 method is selected.
- ✓ **EF for Direct N_2O-N emissions**: contains N_2O EFs for each subcategory/subdivision combination.
- ✓ **Direct N_2O emissions from Manure Management**: calculates Direct N_2O emissions, in mass units (Gg), for each geographical zone/MMS combination of each subcategory/subdivision combination. In addition total emissions are calculated.

[67] oxidation of ammonia nitrogen to nitrate nitrogen. Nitrification is a necessary prerequisite for the emission of N_2O from stored animal manures and it does not occur under anaerobic conditions.
[68] Nitrites and nitrates are transformed to N_2O and N_2 during the naturally occurring process of denitrification, an anaerobic process.

User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 10.4 of the *2006 IPCC Guidelines*, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, for each source category, the users apply steps described in the following flowchart:



Step A, Livestock Manager users stratify the animal population by:

- ✓ Defining geographical zone and assigning an average annual temperature;
- ✓ Selecting predefined livestock subcategories and subdivisions from drop-down menu, and/or entering user-specific subcategories and/or subdivisions, and/or, where relevant, adding animal species and associated subcategories/subdivisions;
- ✓ Selecting manure management systems among those listed and/or, where relevant, adding user-specific MMSs.

Thus, for each population stratum – *i.e. livestock category/subcategory/subdivision in each geographical zone*

Step B, worksheet **Livestock population**, enter in each row *Annual Average Population* and *Typical Animal Mass* data as well as information required to calculate daily *gross energy* need according to the selected tier methodology.

Step C, worksheet **MMS usage**, for each livestock population/subcategory/subdivision allocate manure to management systems.

Step D, worksheets **Average Daily Feed Intake - Simplified** or **Average Daily Feed Intake - Detailed**, enter in each row additional information needed to calculate *average daily feed intake* of relevant livestock population/subcategory/subdivision. The two approaches differ on how the gross energy intake is calculated, either through an energy balance of performances and activities of the population (as maintenance, growth, activity, pregnancy, production) -i.e. Detailed-, or derived from the daily feed intake and its energy content -i.e. Simplified-. Step D applies to Cows populations only.

Step E1, worksheet **N Excretion rate**, for each row of data enter associated daily *N excretion rate*, and the *Software* calculates *annual N excretion rate*. Step E1 does not apply at IPCC Default (Tier 1) method.

Step E2, worksheet **N Excretion rate - Tier 2**:

- for Cattle, for each row of data enter:
  - ✓ either *annual N excretion rate*
  - ✓ or *crude protein in diet,* and calculate or enter:
    - *daily N consumed*
    - *milk protein content* (for livestock populations that produce milk)
    - *fraction of N retained*

    and the *Software* calculates *annual N excretion rate*.
- for other livestock species, for each row of data enter associated *daily N consumed* and *fraction of N retained*, and the *Software* calculates *annual N excretion rate*.

Step E2 applies at IPCC Tier 2 only.

Step F, worksheet **Direct N_2O-N Emission Factor**, for each row of data enter associated *Direct N_2O-N Emission Factor*.

Step G, worksheet **Direct N_2O Emissions from Manure Management**, *Software* calculates Direct N_2O emissions, in mass units (Gg). In addition total emissions are calculated.

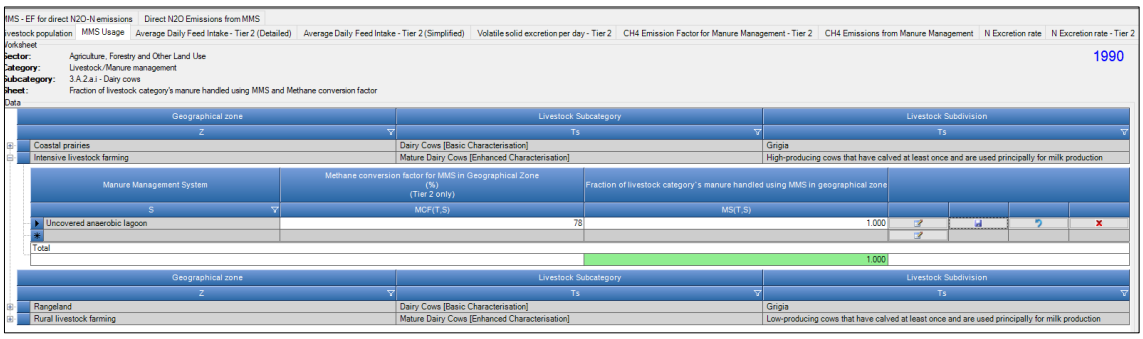
Activity data input

Guidance on data collection and analysis for livestock population characterisation is provided in sections 10.2. and 10.5.3

Activity data are **first** entered in worksheets **Livestock Population** and **average daily feed intake** (for **Cattle only**), **then** in worksheets **MMS usage**, **N excretion rate** (IPCC Default method) or **N Excretion rate – Tier 2** (IPCC Tier 2 method only).

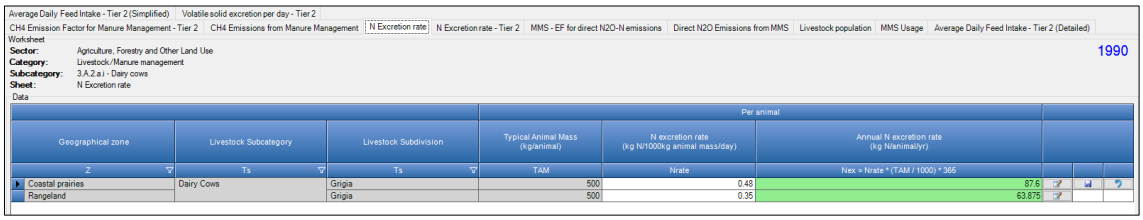
Worksheet **MMS usage** users click the element ⊞ on the left-hand side of the worksheet to access the sub-tab, then row by row data are entered:

1. Column |S|: Select *Manure Management System* from dropdown menu.
   *Note that only MMS input in the **Livestock Manager** (MMS Tab) are listed in the drop-down menu*
2. Column |$MS_{(T,S)}$|: Enter *fraction of manure handled in the MMS*.
   Note that the total of fractions entered shall sum up to 1 (otherwise the relevant cell for "Total" is coloured in red)



Worksheet **N Excretion rate** is prefilled by the *Software* with a number of rows corresponding to the number of subcategories/subdivision/geographical zone combinations and associated *Typical Animal Mass* value entered in worksheet **Livestock population**. Then, when IPCC Tier 2 methodology is NOT applied:

1. Column |N_{rate}|: Select *N excretion rate* from dropdown menu or enter a user-specific value, kg N ton animal mass^{-1} day^{-1};

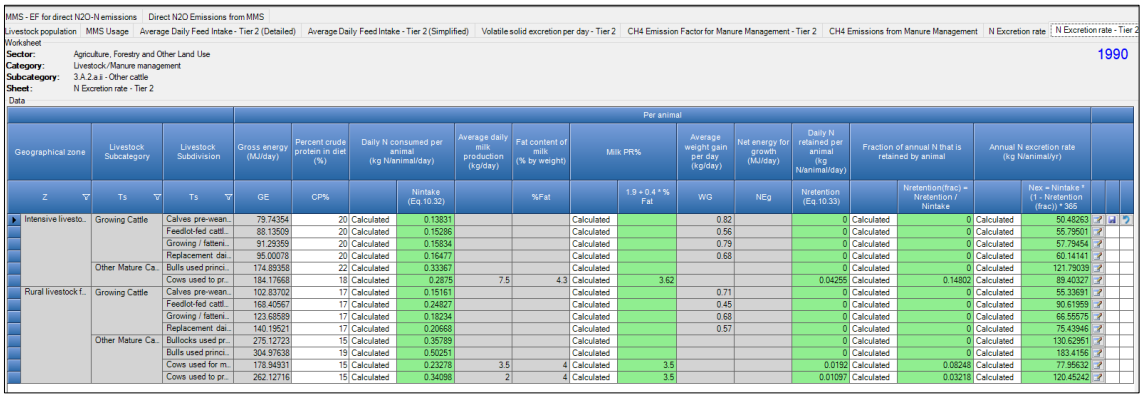


The *Software* calculates *Annual N excretion rate*, kg N animal^{-1} year^{-1}.

Worksheet **N Excretion rate - Tier 2** is prefilled by the *Software* with a number of rows corresponding to the number of subcategories/subdivision/geographical zone combinations, and:

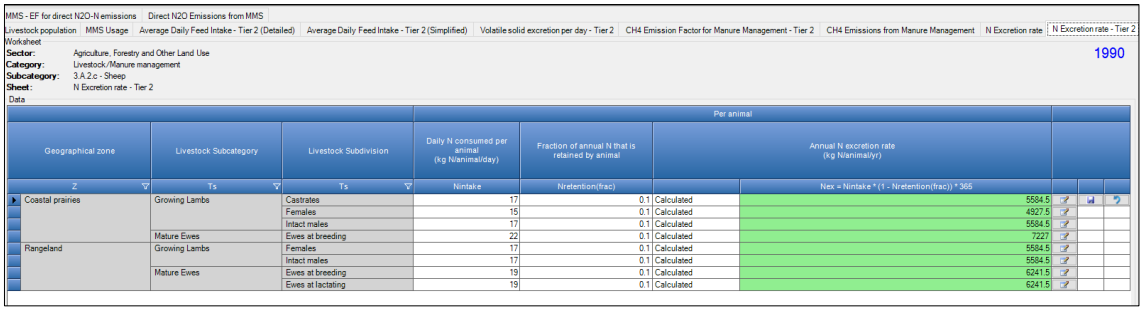
For **Cattle**:

1. Column |CP%|: Enter a user-specific value, percent.
   Note that the 2019 Refinement contains data on percent of crude protein in diet in table 10A.1-10A.3
2. Column |N_{intake}|: Either enter a user-specific value or select to calculate it (no additional data are to be entered), kg N animal^{-1} day^{-1}.
3. Column |$N_{retention(frac)}$|: Either enter a user-specific value or select to calculate it (no additional data are to be entered), fraction.
   Note that the 2019 Refinement contains data on fraction of N retained over N intake in table 10A.1-10A.3
4. Column |N_{ex}|: Either enter a user-specific value or select to calculate it (no additional data are to be entered), kg N animal^{-1} year^{-1}.



For **Other Livestock species**:

1. Column |N_{intake}|: Either enter a user-specific value or select to calculate it (no additional data are to be entered), kg N animal^{-1} day^{-1}.
2. Column |$N_{retention(frac)}$|: Either enter a user-specific value or select to calculate it (no additional data are to be entered), fraction.
3. Column |N_{ex}|: Either enter a user-specific value or select to calculate it (no additional data are to be entered), kg N animal^{-1} year^{-1}.



The *Software* calculates *Annual N excretion rate*, kg N animal^{-1} year^{-1}.

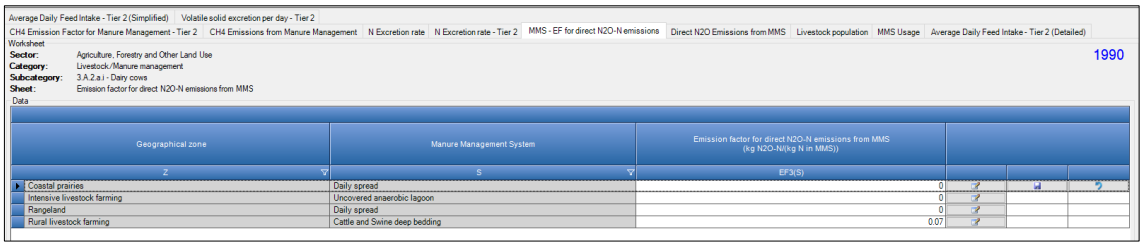
Recall:

press the floppy disk icon on the right-hand side of the worksheet to ensure that information entered in the row is saved in the database.

Emission factor input

Worksheet **EF for Direct N_2O-N emissions** is prefilled by the *Software* with a number of rows corresponding to the number of geographical zone/MMS combinations entered in worksheet **MMS Usage**, and for each row of data:

1. Column $|EF_{3(S)}|$: Select $EF_{3(S)}$ from dropdown menu or enter a user-specific value, kg N_2O-N kg N in MMS^{-1}.

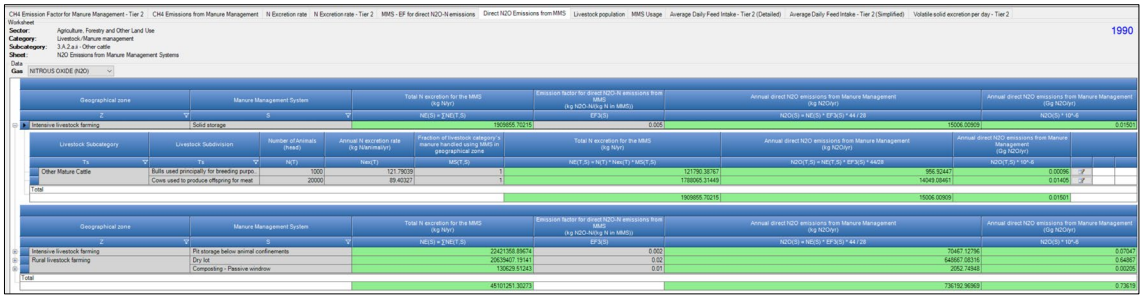


Recall:

press the floppy disk icon on the right-hand side of the worksheet to ensure that information entered in the row is saved in the database.

Results

The *Software* calculates for each row of data Direct N_2O Emissions, in mass unit (Gg), in worksheet **Direct N_2O Emissions from Manure Management**. In addition, total Direct N_2O emissions are calculated.



To access the sub-tab users click the element ⊞ on the left-hand side of the worksheet.

3.C.6 Indirect N_2O emissions from Manure Management

Information

Indirect emissions result from volatile nitrogen losses that occur primarily in the forms of NH_3 and NO_X. N is also lost through runoff and leaching into soils from the solid storage of manure at outdoor areas, in feedlots and where animals are grazing in pastures[69].

To estimate Indirect N_2O emissions from Manure Management users SHALL first estimate Direct N_2O emissions from Manure Management.

IPCC Equations

Indirect N_2O emissions are estimated by applying the following IPCC equations:

- IPCC (Default) Tier 1: Equations 10.26 & 10.27 *limited to indirect N_2O emissions from N volatilization*;
- IPCC Tier 2: Equations 10.28 & 10.29, *limited to indirect N_2O emissions from N leaching/runoff.*

As explained in section **II.1.1 - Use of multiple tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement IPCC Default (Tier 1) equation.

Software Worksheets

The *Software* calculates Indirect N_2O emissions using worksheets:

- ✓ **Livestock Manager**: contains data on stratification of the livestock population by geographical boundaries, species, subcategories, subdivisions, as well as on manure management systems utilized in the NGHGI.
- ✓ **Livestock Population**: contains for each subcategory/subdivision combination, the amount of the population and the typical animal mass, as well as a number of parameters for IPCC Tier 2 methodology to calculate the energy needs of animals.
- ✓ **Average Daily Feed Intake**: depending on the methodological tier selected calculates energy needs for each subcategory/subdivision combination.
- ✓ **MMS Usage**: contains for each subcategory/subdivision combination, MMSs used and the fraction of manure applied to each MMS.
- ✓ **N excretion rate**: contains $N_{excretion}$ rate for each subcategory/subdivision combination, where IPCC default method is selected.
- ✓ **N excretion rate - Tier 2**: calculates $N_{excretion}$ rates based on N inputs (percent of crude protein in diet) and N needs for each subcategory/subdivision combination, where IPCC Tier 2 method is selected.

All above worksheets are used to first estimate category 3.A.2 - Direct N_2O emissions from Manure Management

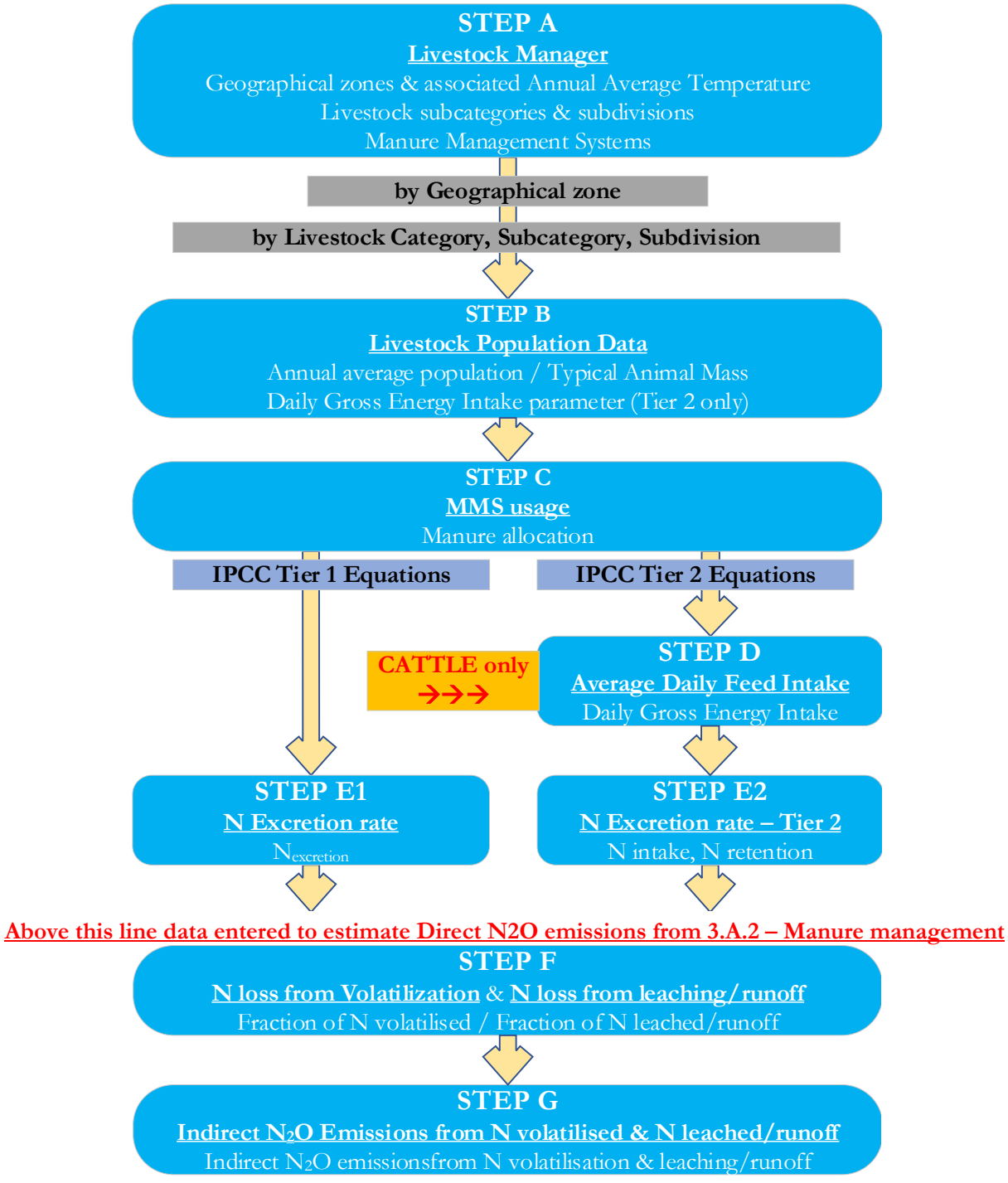
- ✓ **Manure N loss due to volatilisation**: calculates the amount of manure N loss due to volatilisation for each combination of geographical zone/MMS/livestock[70] and associated total N excreted.
- ✓ **Manure N loss due to leaching/runoff**: calculates the amount of manure N loss due to leaching/runoff for each combination of geographical zone/MMS/livestock[71] and associated total N excreted. **IPCC Tier 2 only**.
- ✓ **Indirect N_2O emissions due to N volatilisation from Manure Management**: calculates indirect N_2O emissions due to N volatilisation from Manure Management, in mass units (Gg), for each geographical zone. In addition total emissions are calculated.
- ✓ **Indirect N_2O emissions due to N leaching/runoff from Manure Management**: calculates indirect N_2O emissions due to N leaching/runoff from Manure Management, in mass units (Gg), for each geographical zone. In addition total emissions are calculated.

[69] Indirect N_2O emissions from leaching and runoff of N from pastures, range and paddock are instead reported under category 3.C.5 – Indirect N_2O emissions from managed soils.
[70] As stratified in categories/subcategories/subdivisions.
[71] As stratified in categories/subcategories/subdivisions.

User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 10.4 of the *2006 IPCC Guidelines*, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, for each source category, the users apply steps described in the following flowchart:



For **Steps A to E1/E2** refer to category **3.A.2 - Manure Management - Direct N_2O**.

Step F, worksheets **Manure N loss due to volatilisation** and **Manure N loss due to leaching/runoff**, for each row of data enter associated *fraction of N volatilised* and, although limited to IPCC Tier 2, *fraction of N leached/runoff*.

Step G, worksheets **Indirect N_2O emissions due to N volatilisation from Manure Management** and **Indirect N_2O emissions due to N leaching/runoff from Manure Management**, *Software* calculates Indirect N_2O emissions from N volatilised and from N leached/runoff, in mass units (Gg), respectively. In addition total emissions are calculated.

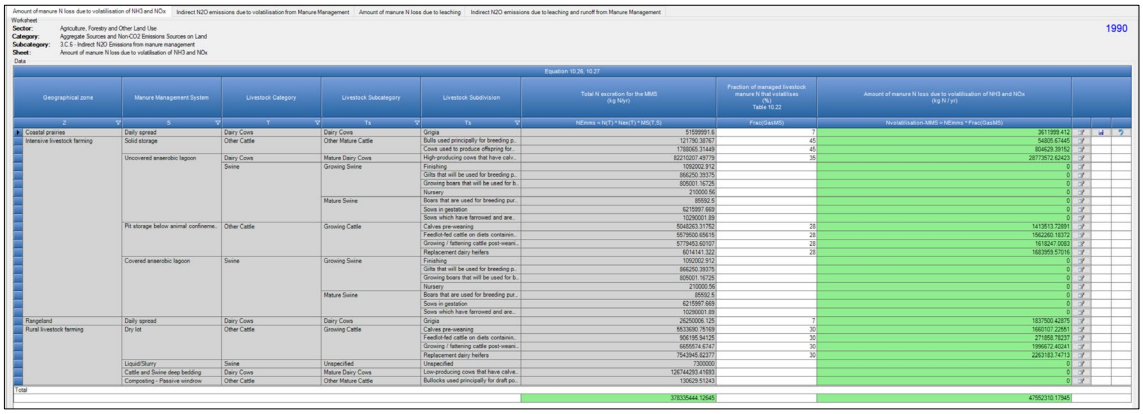
Activity data input

Guidance on data collection and analysis for livestock population characterisation is provided in sections 10.2. and 10.5.3

In addition to Activity data entry described for category 3.A.2, data are entered in worksheets **Manure N loss due to volatilisation** and **Manure N loss due to leaching/runoff** (IPCC Tier 2 method only).

Worksheet **Manure N loss due to volatilisation** row by row data are entered:

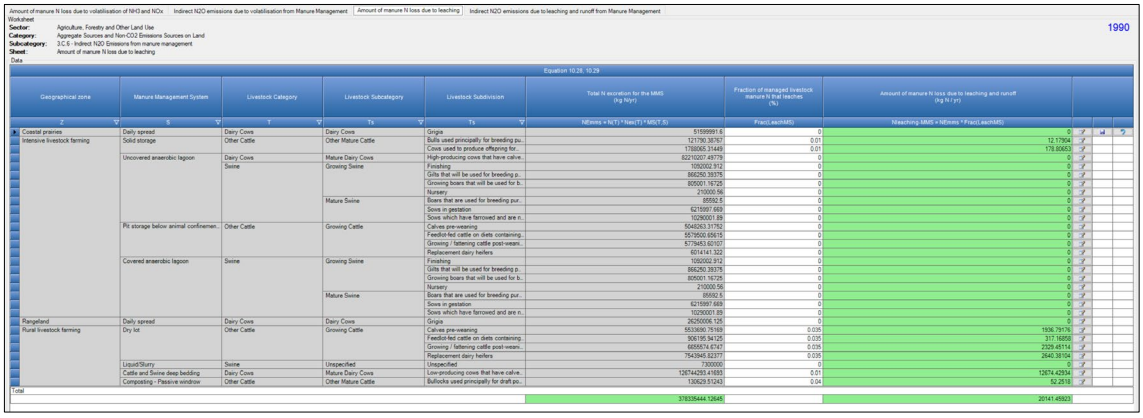
1. Column |$Frac_{GAS(MS)}$|: Select *fraction of N volatilised* from dropdown menu or enter a user-specific value, fraction.



The *Software* calculates *Annual N loss from volatilisation*, kg N year^{-1}.

Worksheet **Manure N loss due to leaching/runoff** row by row data are entered:

1. Column |$Frac_{GAS(MS)}$|: Select *fraction of N volatilised* from dropdown menu or enter a user-specific value, fraction.



The *Software* calculates *Annual N loss from leaching/runoff*, kg N year^{-1}.

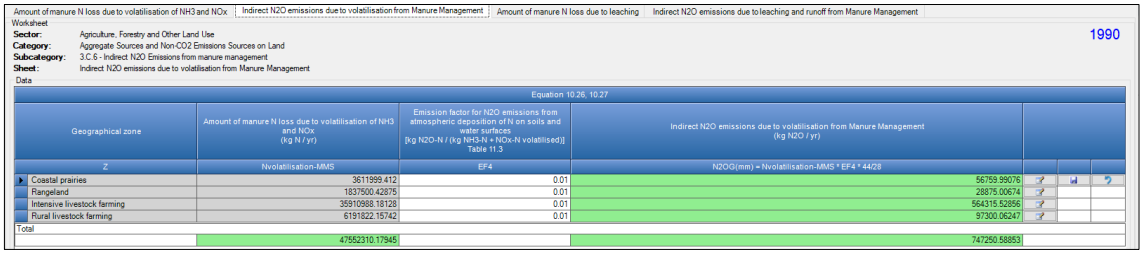
Recall:

press the floppy disk icon on the right-hand side of the worksheet to ensure that information entered in the row is saved in the database.

Emission factor input

Worksheet **Indirect N_2O emissions due to N volatilisation from Manure Management** is prefilled by the *Software* with a number of rows corresponding to the number of geographical zones and associated total manure's N loss due to volatilisation, and for each row of data:

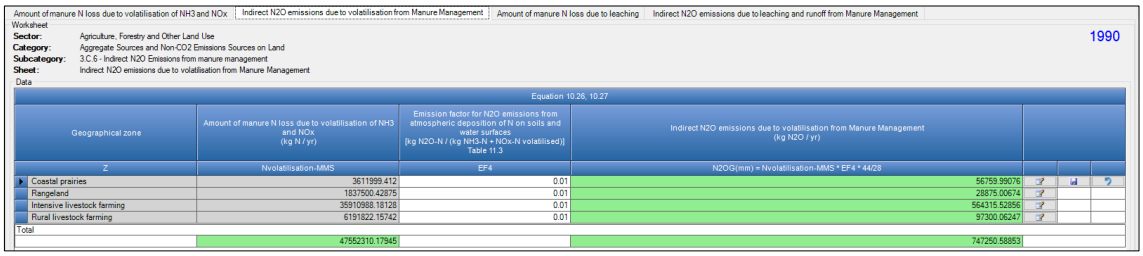
1. Column |EF_4|: Select *EF_4* from dropdown menu or enter a user-specific value, kg N_2O-N (kg NH_3-N & NO_X-N volatilised)$^{-1}$.



Geographical zone	Amount of manure N loss due to volatilisation of NH3 and NOx (kg N / yr)	Emission factor for N2O emissions from atmospheric deposition of N on soils and water surfaces [kg N2O-N / (kg NH3-N + NOx-N volatilised)] Table 11.3	Indirect N2O emissions due to volatilisation from Manure Management (kg N2O / yr)
Z	Nvolatilisation-MMS	EF4	N2OG(mm) = Nvolatilisation-MMS * EF4 * 44/28
Coastal prairies	3611999.412	0.01	56759.99076
Rangeland	1837500.42876	0.01	28875.00674
Intensive livestock farming	35910988.18128	0.01	564315.52856
Rural livestock farming	6191822.15742	0.01	97300.06247
Total	47552310.17945		747250.58853

Worksheet **Indirect N_2O emissions due to N leaching/runoff from Manure Management** is prefilled by the *Software* with a number of rows corresponding to the number of geographical zones and associated total manure's N loss due to leaching/runoff, and for each row of data:

1. Column |EF_4|: Select EF_5 from dropdown menu or enter a user-specific value, kg N_2O-N (kg NH_3-N & NO_X-N leached/runoff)$^{-1}$.



Recall:

press the floppy disk icon on the right-hand side of the worksheet to ensure that information entered in the row is saved in the database.

Results

The *Software* calculates for each row of data Indirect N_2O Emissions, in mass unit (Gg), in worksheets **Indirect N_2O emissions due to N volatilisation from Manure Management** and **Indirect N_2O emissions due to N leaching/runoff from Manure Management**. In addition, total Indirect N_2O emissions are calculated in each worksheet.

Annex I: Mapping between the IPCC Inventory Software and the UNFCCC ETF Reporting Tool

The *Software* enables users to calculate national GHG emissions in accordance with the *2006 IPCC Guidelines*. The methods contained in the *Software* are consistent with those required to be used by Parties in preparing a national GHG inventory, consistent with decision 18/CMA.1, under the Enhanced Transparency Framework (ETF) of the Paris Agreement. However, Parties to the UNFCCC have agreed to a specific format for reporting the GHG inventory information, called the common reporting tables (CRT), that differ from the IPCC reporting tables contained in volume 1, chapter 8 of the *2006 IPCC Guidelines*.

Thus, Parties to the UNFCCC, acknowledging the importance of the *Software* in aiding countries to estimate their national GHG inventory, have invited IPCC to work together to facilitate interoperability between the *Software* and the UNFCCC electronic reporting tool. Consequently, the *Software* has been upgraded to operationalize the interoperability. Specifically, users of the *Software* can estimate GHG emissions and removals for all categories and gases that are required to be reported pursuant to the CRT. Once data are entered into the *Software*, users wishing to use these data to facilitate reporting to the UNFCCC must generate a file in the *Software* (in JSON format). This file, can then subsequently, through a separate UNFCCC platform, be uploaded and further processed through the UNFCCC electronic reporting tool to transfer to UNFCCC their national GHG inventory, as compiled in the CRTs and as required under the Paris Agreement.

Preparing a JSON file that can be imported into the UNFCCC electronic reporting tool required a cell-by-cell mapping of the CRT to document where each of the AD and GHG emissions estimates contained in each worksheet of the *Software* reside in the CRT.

This annex contains detailed information to illustrate the mapping of data on livestock-related categories -i.e. **3.A.1 - Enteric Fermentation**, **3.A.2 - Manure Management**, **3.C.6 - Indirect N_2O emissions from manure management**- between the *Software* and the CRTs. The specific information presented in this annex related to reporting of emissions from livestock-related categories in the CRT is supplemental to the general information provided in the **IPCC Inventory Software -UNFCCC Interoperability – CRT Export Quick Start Guide**.

Table A.1.1 compares livestock Categories between the **Livestock Manager** in the *Software* and the CRT.

Table A.1.1 Mapping of livestock categories between the Software and the CRT

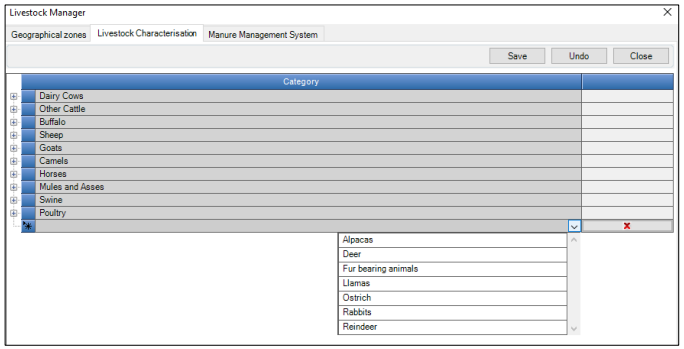
Category				Notes
Software		CRT		
code[A]	Livestock Manager	code[A]	Livestock category	
3.A.1.a 3.A.2.a	Cattle	3.A.1 3.B.1	Cattle	If users do not enter any livestock subcategory/subdivision in the **Livestock Manager** -neither under *Dairy Cows* nor under *Other Cattle*- then, data on *Dairy Cows* in the *Software* will map to CRT ***OPTION A*** - *Dairy cattle*, and data on *Other Cattle* in the *Software* will map to CRT ***OPTION A*** - *Non-dairy cattle*. If users enter any Cattle's subcategory in the **Livestock Manager** -either under *Dairy Cows* or under *Other Cattle*- then data will map to CRT ***OPTION B*** as follows: - All subcategories/subdivisions of *Dairy Cows* in the *Software* will map to CRT *Mature dairy cattle* - All subdivisions of *Growing cattle* in the *Software* will map to CRT *Growing Cattle* - All subdivisions to *Other Mature cattle* as well as any user-specific subcategory of *Other Cattle* (e.g. beef cattle-pasture) in the *Software* will map to CRT *Other mature cattle.* - No data map to *3.A.1.a.iv - Other (please specify)* in the CRT, so *NA* is populated in the CRT.
3.A.1.a.i 3.A.2.a.i	*Dairy Cows*	3.A.1.a 3.B.1.a	***Option A*** *Dairy cattle*	
		3.A.1.a.i 3.B.1.a.i	***Option B*** *Mature dairy cattle*	
3.A.1.a.ii 3.A.2.a.ii	*Other Cattle*	3.A.1.b 3.B.1.b	***Option A*** *Non-dairy cattle*	
		3.A.1.a.ii 3.B.1.a.ii	***Option B*** *Other mature cattle*	
		3.A.1.a.iii 3.B.1.a.iii	***Option B*** *Growing cattle*	
3.A.1.c 3.A.2.c	Sheep	3.A.2.a 3.B.2.a	Sheep	*Sheep* category[72] in the *Software* map to a single row in the CRT, labelled *All sheep*.
3.A.1.h 3.A.2.h	Swine	3.A.3.a 3.B.3.a	Swine	*Swine* category[73] in the *Software* map to a single row in the CRT, labelled *All swine*.
		3.A.4 3.B.4	Other livestock	
3.A.1.b 3.A.2.b	Buffalo	3.A.4.a 3.B.4.a	Buffalo	
3.A.1.e 3.A.2.e	Camels	3.A.4.b 3.B.4.b	Camels	
3.A.1.d 3.A.2.d	Goats	3.A.4.d 3.B.4.d	Goats	

[72] and associated subcategories/subdivisions, if any - e.g. mature ewes, growing lambs, other mature sheep.
[73] and associated subcategories/subdivisions, if any - e.g. mature swine, growing swine.

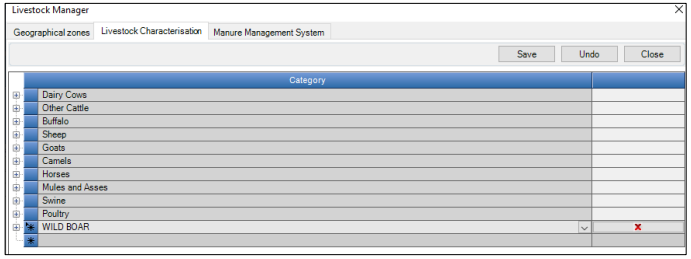
Category				Notes
Software		CRT		
code	Livestock Manager	code	Livestock category	
3.A.1.f 3.A.2.f	Horses	3.A.4.e 3.B.4.e	Horses	
3.A.1.g 3.A.2.g	Mules and Asses	3.A.4.f 3.B.4.f	Mules and Asses	
3.A.1.i 3.A.2.i	Poultry	3.A.4.g 3.B.4.g	Poultry	
Dropdown menu[B]				All additional livestock species are reported in IPCC categories 3.A.1.j (other) and 3.A.2.j (other) for Enteric fermentation and Manure management respectively.
3.A.1.j 3.A.2.j	Deer	3.A.4.c 3.B.4.c	Deer	
		3.A.4.h 3.B.4.h	Other	
	Rabbit	3.A.4.h.i 3.B.4.h.i	Rabbit	
	Reindeer	3.A.4.h.ii 3.B.4.h.ii	Reindeer	
	Ostrich	3.A.4.h.iii 3.B.4.h.iii	Ostrich	
	Fur-bearing animals	3.A.4.h.iv 3.B.4.h.iv	Fur-bearing animals	
		3.A.4.h.v 3.B.4.h.v	Other (*please specify*)	
	Alpacas		Alpacas [IPCC Software 3.A.2.j]	
	Llamas		Llamas [IPCC Software 3.A.2.j]	
	Any user-specific		All other species [IPCC Software 3.A.2.j]	any additional user-specific livestock category, as entered in the **Livestock Manager**, will map to a single row in the CRT

[A] *(codes are provided for both sources: Enteric fermentation and Manure management)*

[B] *Where estimates are to be prepared by users for livestock species listed hereafter, those species are to be added by selecting in the dropdown menu of the Livestock Characterization TAB in the* ***Livestock Manager****. Users can also add livestock species not included in the dropdown menu by directly entering those in the last row of the TAB.*



Selecting additional livestock species from dropdown menu



Adding livestock species

Table A.1.2 lists every manure management system referenced in Table 10.18 Definitions of Manure Management Systems in the 2006 IPCC Guidelines and the corresponding manure management system to which it is mapped in the CRT. For example, reporting manure treated in an "uncovered anaerobic lagoon" in the *Software* maps to "Anaerobic lagoon" in the CRT, and the four different systems for composting in the *Software* all map to "Composting" in the CRT.

Table A.1.2 Mapping of Manure Management Systems between the Software and the CRT

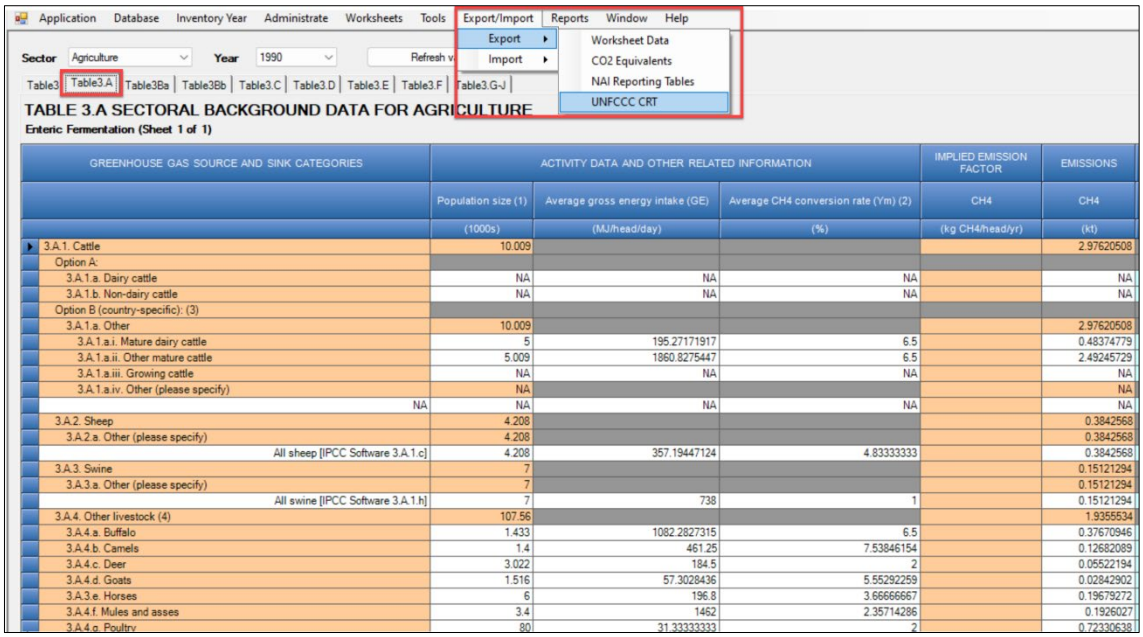
IPCC Inventory Software *(from Table 10.18)*	**CRT - Tables 3.A, 3.B(a) and 3.B(b)**
Uncovered anaerobic lagoon	Anaerobic lagoon
Liquid/Slurry	Liquid system
Daily spread	Daily spread
Solid storage	Solid storage
Pit storage below animal confinements	Pit storage
Dry lot	Dry lot
Cattle and Swine deep bedding	Deep bedding
Pasture/Range/Paddock	Pasture, range, and paddock
Composting- in-vessel Composting - static pile Composting intensive windrow Composting, Passive windrow	Composting
Anerobic digester	Digesters
Burned for fuel	Burned for fuel or as waste
Poultry manure with litter Poultry manure without litter Aerobic treatment *Country-specific*	Other

CRT visualization tables in the IPCC Inventory Software

The mapping between the *Software* and the CRT are visualized in the *Software* to allow the user to properly understand, and keep for internal use, the results of the conversion of IPCC category GHG estimates into UNFCCC NGHGI categories, thus enhancing transparency.

To generate the visualization tables, select from the ribbon "Export/Import" and then "UNFCCC CRT" to generate the tables. For complete guidance on how to do this, refer to the **IPCC Inventory Software -UNFCCC Interoperability – CRT Export Quick Start Guide**. The result of the generated tables is presented in Table A.1.3 below.

Table A.1.3 Illustration of Visualized CRT table 3.A (Enteric Fermentation) in the Software



GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ACTIVITY DATA AND OTHER RELATED INFORMATION			IMPLIED EMISSION FACTOR	EMISSIONS
	Population size (1)	Average gross energy intake (GE)	Average CH4 conversion rate (Ym) (2)	CH4	CH4
	(1000s)	(MJ/head/day)	(%)	(kg CH4/head/yr)	(kt)
3.A.1. Cattle	10.009				2.97620508
Option A:					
3.A.1.a. Dairy cattle	NA	NA	NA		NA
3.A.1.b. Non-dairy cattle	NA	NA	NA		NA
Option B (country-specific): (3)					
3.A.1.a. Other	10.009				2.97620508
3.A.1.a.i. Mature dairy cattle	5	195.27171917	6.5		0.48374779
3.A.1.a.ii. Other mature cattle	5.009	1860.8275447	6.5		2.49245729
3.A.1.a.iii. Growing cattle	NA	NA	NA		NA
3.A.1.a.iv. Other (please specify)	NA				NA
NA	NA	NA	NA		NA
3.A.2. Sheep	4.208				0.3842568
3.A.2.a. Other (please specify)	4.208				0.3842568
All sheep [IPCC Software 3.A.1.c]	4.208	357.19447124	4.83333333		0.3842568
3.A.3. Swine	7				0.15121294
3.A.3.a. Other (please specify)	7				0.15121294
All swine [IPCC Software 3.A.1.h]	7	738	1		0.15121294
3.A.4. Other livestock (4)	107.56				1.9355534
3.A.4.a. Buffalo	1.433	1082.2827315	6.5		0.37670946
3.A.4.b. Camels	1.4	461.25	7.53846154		0.12682089
3.A.4.c. Deer	3.022	184.5	2		0.05522194
3.A.4.d. Goats	1.516	57.3028436	5.55292259		0.02842902
3.A.3.e. Horses	6	196.8	3.66666667		0.19679272
3.A.4.f. Mules and asses	3.4	1462	2.35714286		0.1926027
3.A.4.g. Poultry	80	31.33333333	2		0.72330638

IMPORTANT: these visualization tables have been prepared to enhance transparency and demonstrate to the user how the data entered in the *Software* are mapped to the UNFCCC CRT. The data entered in the *Software* are not automatically used to meet the UNFCCC reporting requirements. The user will still be required to formally submit the information through the UNFCCC electronic reporting tool for CRT, and the user is responsible for reviewing first the information compiled in the CRT visualization tables, and second the information once imported into that tool.

How to read mapping tables

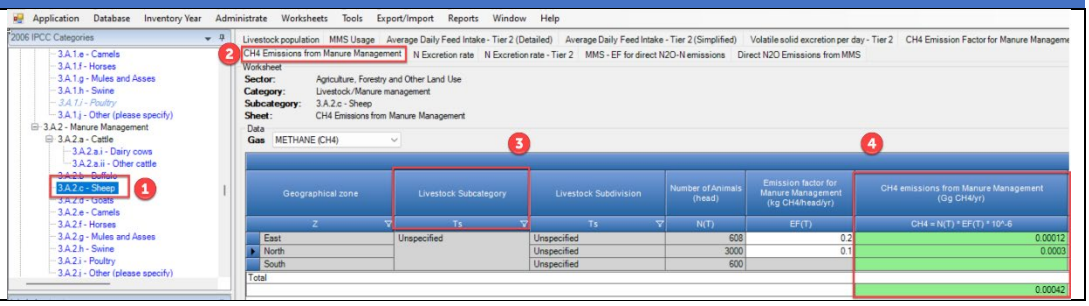
The mapping tables have been developed to enhance transparency of the relationship between the categories in the *Software* and the UNFCCC reporting tool for CRT. For each cell in the CRT, the mapping tables describe the source of the data from the *Software* that is reported in that cell. The majority of cells in the CRT map from the underlying category-specific worksheets of the *Software*. In limited cases (e.g. for some short-lived climate forcer emissions in the sector summary tables) data are mapped from the IPCC background or sectoral reporting tables.

The specific mapping instructions vary, depending on the nature of the category, and how many calculation worksheets from the *Software* map to that cell, but generally, the instruction is written to direct the user to:

1. The specific IPCC category in the category tree
2. The tab in that worksheet that contains the relevant information; in the case of the reporting of livestock emissions in CRT tables 3.A, 3.B(a) and 3.B(b), reference in the mapping is often made to one of the three tabs of the Livestock Manager: Geographical zones, Livestock Characterisation and Manure Management System
3. The relevant livestock category(categories) when a single worksheet includes multiple livestock type
4. The column that contains the relevant information, with an indication of any mathematical operation needed (e.g. SUM, MULTIPLY BY, etc)
5. Any conversions needed to ensure correct units map to the UNFCCC CRT (e.g. DIVIDE by 1,000 to convert Population to Population (1,000s)).

By illustration, the directions in the mapping file to report total CH_4 emissions from manure management of sheep in the CRT, and the corresponding location of the information in the *Software* are shown below in Table A.1.4. The user would refer to category 3.A.2.c in the *Software*, which refers to manure management of sheep, and then the worksheet for CH_4 emissions from manure management. You will see that mapping file includes the total sum of the column "CH_4", this is because the CH_4 emissions from all types of sheep will map to the single cell in the CRT. Generally, white cells in the CRT are mapped from the *Software*. Orange, green, or blue cells in the visualized CRT in the *Software* will be calculated by the UNFCCC electronic reporting tool for CRT, upon import of the JSON file.

Table A.1.4 Example: How to read mapping between the Software and the UNFCCC CRT

UNFCCC CRT	**GREENHOUSE GAS SOURCE AND SINK CATEGORIES**	**EMISSIONS** CH_4 (kt)
	3.B.2. Sheep	SUM(K23)
	3.B.2.a. Other *(please specify)*	SUM(K24)
	All sheep [IPCC Software 3.A.2.c]	IPCC 3.A.2.c <CH4 Emissions from Manure Management> SUM Column "CH4", if SUM=0 or blank then "NE"
IPCC Inventory Software		

The example above is a simple illustration. In some cases, multiple worksheets and even multiple categories may map to a single cell in the CRT. This would be illustrated by reference to the two key instructions "PLUS" or "AND" to denote consideration of multiple data elements from the *Software*.

The following recurrent key instructions in the mapping are:

- ✓ The sign **"SUM"** indicates a summatory of information (numerical or alphabetical) contained across the column/row to which applies.
- ✓ The sign **"-SUM"** indicates that the result of the summatory is to be reported as a negative value.
- ✓ The sign **"AND"** indicates an additional element for mapping in the cell, which pertains to the same IPCC category.
- ✓ The sign **"PLUS"** indicates an additional element for mapping in the cell, which pertains to an additional IPCC category.
- ✓ The signs **"MINUS"** indicates an additional element for mapping in the cell, which information pertains to a different IPCC category and it is to be subtracted.
- ✓ The signs **"EXCEPT"** indicates an element for mapping to be excluded because this element (e.g. fuel or IPCC category) is already included elsewhere.
- ✓ The signs **"MULTIPLY"** and **"DIVIDE"** and **"SUBTRACT"** indicate the corresponding mathematical operation to be applied to information sourced from the *Software*.
- ✓ The signs **"ISNOT"** means ≠.
- ✓ The indication **"AVERAGE…WEIGTHED by"**.

There are two unique elements for the mapping of livestock that are relevant to highlight:

1. **The basic characterization versus an enhanced characterization for cattle.** As explained in Table A.1.1, the CRT allows two, mutually exclusive options for reporting of cattle emissions: Option A, divided between *Dairy cattle* and *Non-dairy cattle* (i.e. a basic characterization), and Option B, divided among *Mature dairy cattle*, *Growing cattle*, *Other mature cattle*, and *Other (please specify)* (i.e. an enhanced characterization). If you do not have any livestock subcategories for cattle entered in the Livestock Manager, all cattle will map to Option A, with Option B reported as "NA" (not applicable). Alternatively, if you have a livestock subcategory under either *Dairy Cows* or *Other Cattle* in the **Livestock Manager**, your data will map to Option B, with Option A reported as "NA".
2. **CRT tables 3.A and 3.B also include a section to enter "Additional information" in cases where Tier 2 is used**. The additional information for table 3.A will be completed when relevant information is entered into the *Software,* even with a basic characterization (i.e. no livestock subcategories entered in the **Livestock Manager** under either *Dairy Cows* or *Other Cattle*). Additional information for CRT table 3.B(a) will only be completed with relevant information when an enhanced characterization is entered (i.e. a livestock subcategory is entered into the **Livestock Manager**) **and** the corresponding worksheets for IPCC category 3.A.1 and 3.A.2 designate the use of a *Tier 2 (Simplified)* or *Tier 2 (Detailed)* in the column Method. An example worksheet is shown in Figure A.1.1 below and a flowchart provided in Figure A.1.2.

Figure A.1.1 Designating Tier 2 for Choice of Method for Cattle

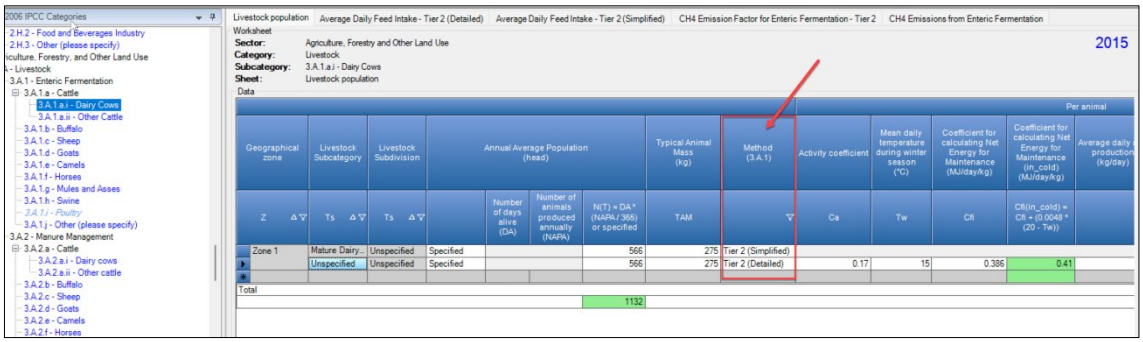
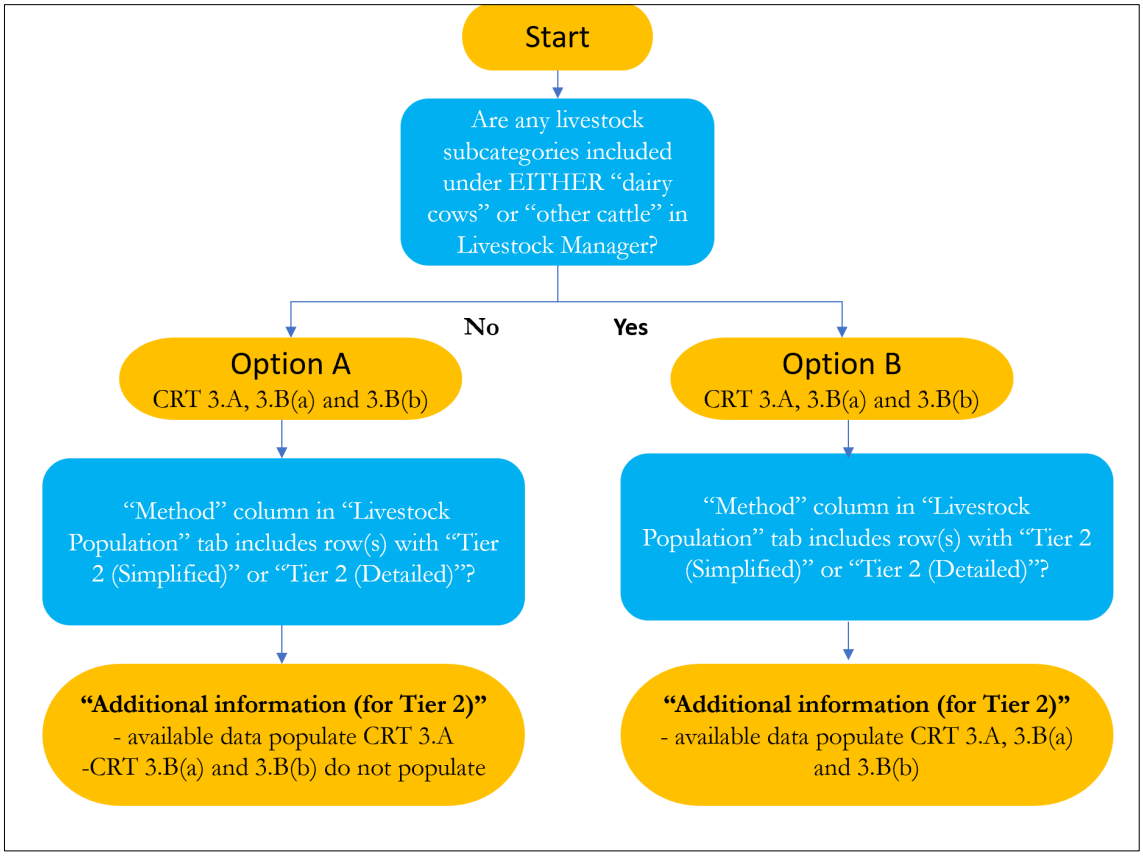


Figure A.1.2 Flowchart of Relationship between Livestock Manager and Reporting in CRT



3. **Data input in the Livestock Manager will influence where data are mapped to the CRT.** In addition to the use of the Livestock Manager to identify, and subsequently map the livestock types in the country, the annual average temperature for each geographic zone and the manure management system(s) entered into the Livestock Manager are referenced when completing the worksheets (e.g, for the additional information table for CRT table 3.B(a)).

Table A.1.5 below demonstrates an example where a livestock subcategory under cattle is added into the Livestock characterisation tab of the Livestock Manager, and thus reporting is for Option B. The instructions then refer the mapping to the "MMS Usage tab of IPCC category 3.A.2.a.i. The geographic zones included in this cell are only those in cool temperatures (as defined in the Geographic Zones tab of the Livestock Manager), and the calculation is referring to the fraction of livestock in those zones as a fraction of total livestock handled in anaerobic lagoons.

Table A.1.5 Example for Dairy Cattle Mapping

Additional information (for Tier 2) [a]				
				Manure Management Systems [b]
Animal category		**Indicator**	**Climate region**	**Anaerobic lagoon**
Option A	**Dairy cattle**	Allocation (%)	Cool	NA
			Temperate	NA
			Warm	NA
		MCF [c]	Cool	NA
			Temperate	NA
			Warm	NA
	Non-dairy cattle	Allocation (%)	Cool	NA
			Temperate	NA
			Warm	NA
		MCF [c]	Cool	NA
			Temperate	NA
			Warm	NA
Option B	**Mature dairy cattle**	Allocation (%)	Cool	IPCC 3.A.2.a.i <MMS Usage, Geographical Zones with average annual temperature <15°C, MMS="Uncovered Anaerobic Lagoon"> (SUM Column "MS(T,S)" DIVIDED by <MMS Usage, Geographical Zones with average annual temperature <15°C, MMS=ALL> SUM Column "MS(T,S)") MULTIPLIED by 100), if RESULT=0 or blank then "NE"

Detailed mapping between the Software and the UNFCCC ETF Reporting Tool

Attached to this PDF of the Guidebook are the UNFCCC CRT agreed by Parties for reporting under the Paris Agreement, and the corresponding mapping instructions from the *Software* for the entire AFOLU sector. Although this guide focuses on IPCC Category 3.A for Livestock, all mapping tables for the AFOLU sector are provided in the attachment owing to the inter-relationship among categories in this sector.

Please note that the tables are accessible by clicking the ATTACH icon (paper-clip) on the left-hand side of your screen.

You will notice that that there are notation keys automatically populated in some cells of the visualized CRT Tables 3, 3.A, 3.A(a) and 3.A(b), as well as some cells highlighted in green, as described in Table A.1 6 below. Unless otherwise specified, "NA" is automatically populated in the CRT in cases where a gas is not applicable for a category in the 2006 IPCC Guidelines, and "NE" where there are no methods in the 2006 IPCC Guidelines for a specific category. In some cases, "IE" (included elsewhere) is automatically populated in the visualized CRT. Finally, there are a few cases in the visualized agriculture sector of the CRT where cells are highlighted green (e.g. additional information under CRT 3.A and nitrogen fraction of biomass in CRT table 3.E. Users can enter information directly into these pale green cells of the CRT. Table A.1 6 explains the existence of notation keys for each table relevant for reporting of GHG emissions from livestock.

Table A.1.6 Automatic Reporting of Notation Keys in the Agriculture Sector of the CRT

CRT Table	CRT category	Parameter/ Gas	Automatic mapping	Explanation
Table 3	3.B.1.a.i Mature dairy cattle	NMVOC	IE	NMVOC emissions are automatically reported in CRT category 3.B.1.a. Dairy cattle
	3.B.1.a.ii Other mature cattle	NMVOC	IE	NMVOC emissions are automatically reported in CRT category 3.B.1.b. Non-dairy cattle
	3.B.1.a.iii Growing cattle	NMVOC	IE	NMVOC emissions are automatically reported in CRT category 3.B.1.b. Non-dairy cattle
	3.B.1.a.iv Other	NMVOC	IE	NMVOC emissions are automatically reported in CRT category 3.B.1.b. Non-dairy cattle
3.A	3.A.1.a.iv Other (*please specify*)	AD / CH_4	NA	This category is automatically reported as *NA*. User-specific Cattle's subcategories will instead map to CRT category *Other mature cattle*.
3.B(a)	3.B.1.a.iv Other (*please specify*)	AD / CH_4	NA	This category is automatically reported as *NA*. User-specific Cattle's subcategories will instead map to CRT category *Other mature cattle*.
3.B(b)	3.B.1.a.iv Other (*please specify*)	AD / N_2O	NA	This category is automatically reported as *NA*. User-specific Cattle's subcategories will instead map to CRT category *Other mature cattle*.
3.D	Additional information	$Frac_{GASPRPR}$	IE	$Frac_{GASPRP}$ is included in $Frac_{GASM}$
3.D	Additional information	Other fractions (*please specify*)	NO	No other default fractions are applied in the *Software*. Should additional fractions be used, those can be described in the documentation box and/or added in UNFCCC ETF Reporting Tool