SNAP CODE: **100000**

SOURCE ACTIVITY TITLE: **AGRICULTURE: INTRODUCTORY REMARKS**

NOSE CODES: **Various**

NFR CODES: **Various**

1 OBJECTIVE

Section 10 of this Guidebook covers the core processes of arable and animal agriculture and structures them according to SNAP 97. This introduction aims at a compilation of the processes described, the gases or species emitted, and the methodology. It also indicates where processes, which are not described in this section, are dealt with in the Guidebook. Besides, it provides a definition that helps to differentiate agricultural and natural processes or sources.

The structure of the section reflects the reporting procedures rather than the calculation procedures. Therefore, it flags those peculiarities where reporting and calculation fall apart or where the calculation procedure requires data from a process covered by another chapter.

2 COVERAGE

Agriculture is a branch of industry which cultivates land and keeps animals in order to produce food, fodder or raw materials used for industrial processes, and comprises arable agriculture, animal agriculture, horticulture, viniculture, etc., with a wide range of intensities. In principle, a sharp distinction between agriculture and natural systems is impossible, as even these systems are used intentionally for food, fodder or animal production and – at least in Europe – are almost everywhere subject to management measures. In order to avoid double counting or omission of sources, we therefore define in accordance with Winiwarter et al. (1999) and Simpson et al. (1999) that **agriculture does not include**:

- Forest foliar emissions (even if the forests are heavily managed);
- Forest fire emissions;
- Natural grassland and other low vegetation, including lands used for grazing only (such as mountain sheep walks);
- Soils;
- Wetlands;
- Waters;
- Wild animals;
- Humans;
- Lightning;
- Volcanoes;
- Gas seeps.

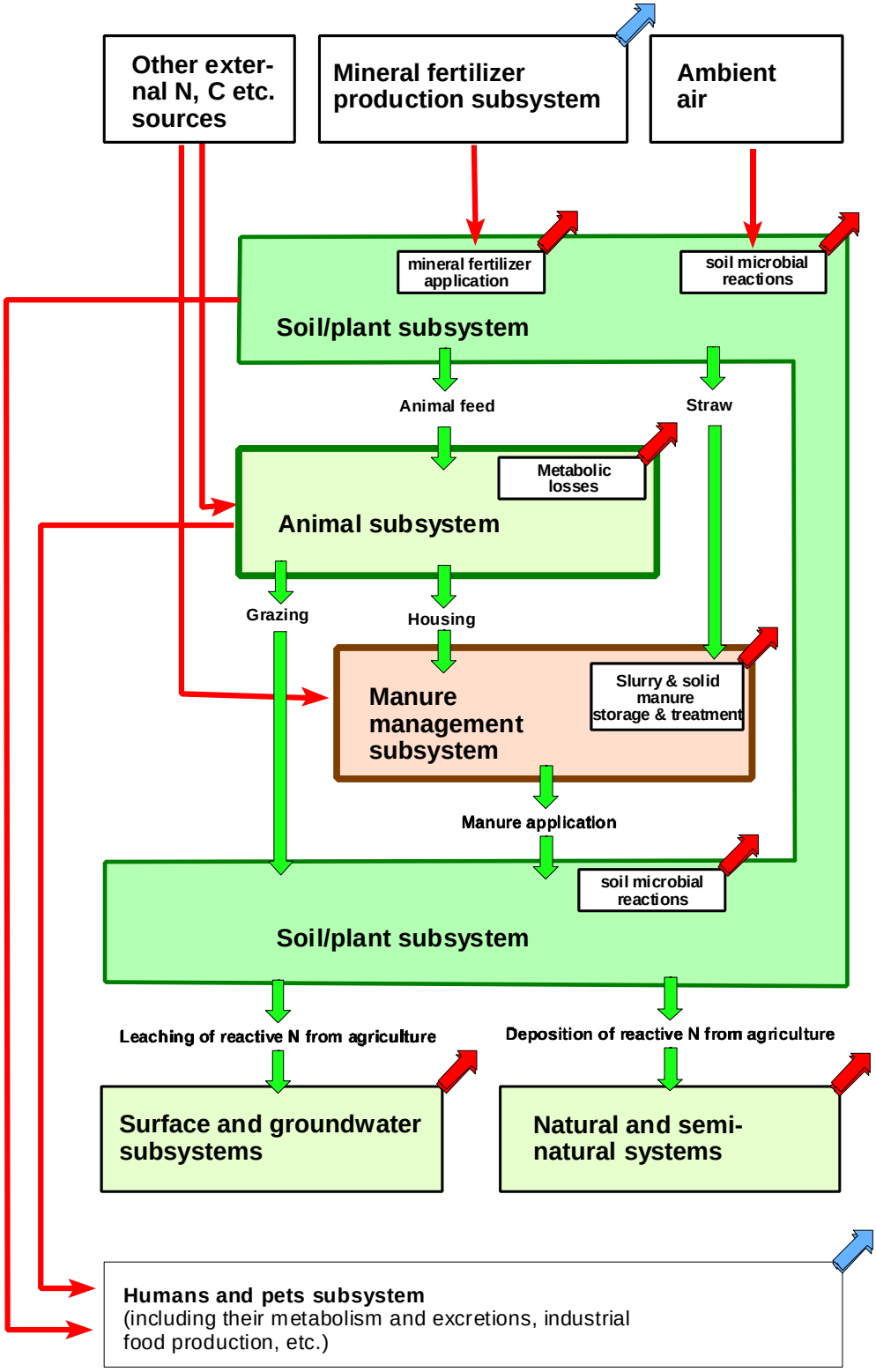

Fig. 1: Mass flows considered in the EMEP/CORINAIR Guidebook Chapter 10 (Agriculture): Red arrows: mass flow between external sources and sinks and the agricultural subsystems; broad red arrows: emissions to the atmosphere. Green arrows: fluxes between agricultural subsystems. Blue arrows: emissions not accounted for as agricultural emissions (Dämmgen et al., 2003)

In principle, **CO_2 emissions** from agricultural processes due to soil, plant and animal breathing are not covered by this Guidebook section, as the combination of photosynthesis and breathing in agriculture and the humans and pets subsystem are balancing one another; and agriculture is considered neither a net source or sink. CO_2 released from the application of lime is considered an agricultural emission. By definition, only the non-energy processes and breeding are covered in section 10. CO_2 emitting processes that relate to agriculture such as fertilizer production are dealt with in other sections (see below).

Guidebook chapters in section 10 deal with emissions from the agricultural production system as a function of the fluxes outlined in Fig. 1:

Chapters 1 and 2 describe emissions from the plant production subsystem. The productivity of this system and the amount of gases emitted are a function of fertilizer input from external (mineral fertilizer) and internal sources (manure application). Emissions resulting from the input of lime and pesticides are quantified in chapter 6. Emissions from burning of organic material on the field site is subject of chapter 3.

Chapter 4 describes losses in the animal subsystem. It contains the emissions from metabolic processes within animals, in particular from enteric fermentation.

Chapters 5 and 9 depict manure management processes including losses from animal excreta in houses, during storage and spreading.

However, the treatment of agricultural emissions within Guidebook section 10 is somewhat inconsistent, as some emissions are dealt with independent of the structure provided in Fig. 1. Tables 1 to 4 are to give an overview. Herein, emissions of gases (Tables 1 to 3) and particles (Table 4) from various categories **structured** with regard to the activities governing them. These activities are listed as in the SNAP coding, though this coding is not always consistent. The tables indicate which type of methodology is available in the present Guidebook edition: **S**: Simpler methodology available; **D**: detailed methodology available. If information is provided to feed in national data rather then default data, the methodology is called “improved”, and the information “**I**” is given in the table. In some cases, hints to establish a first estimate ("**FE**") are provided.

Table 1: Classification of activities according to EMEP/CORINAIR (2001) and attribution to SNAP (2001): ***gases from arable agriculture***

Category	Activity	SNAP	NH_3	N_2O	NO	CH_4	CO_2	NM VOC	PM	Remarks
Cultures with Fertilizers	Emissions from fertilizer N applied	10 01 00	**S, D**	**S, I**	**S, I**	**x**		**FE**		(1)
(Fertilized Agricultural Land)	Grazed grassland	10 01 00	**S**							
	Rice fields	10 01 00	**D**			**x**				(2)
	Organic soils	10 01 00		**S**			**x**			(3)

(1) CH_4: A method to quantify CH_4 consumption is given.
(2) CH_4: A hint towards the IPCC methodology is given.
(3) CO_2: A method to estimate the order of magnitude of emissions is proposed.

Table 1 (continued): Classification of activities according to EMEP/CORINAIR (2001) and attribution to SNAP (2001): ***gases from arable agriculture***

Category	Activity	SNAP	NH_3	N_2O	NO	CH_4	CO_2	NM VOC	PM	Remarks
Cultures without Fertilizers	Legumes	10 02 00	**S, D**							
	Unfertilized grassland	10 02 00	**S**							
	Unfertilized agricultural soils	10 02 00		**S**	**S**					
	Indirect emissions due to deposition of reactive nitrogen species	10 02 00		**S**	**S**					
	Indirect emissions due to leaching and run-off of reactive nitrogen species	10 02 00		**S**	**S**					
Stubble Burning	On field burning of stubble, straw etc.	10 03 00	**S**						**S**	(1)
Pesticides and Limestone	Pesticides	10 06 00					**S**	**S**		
Natural Grasslands and other vegetation	Natural grasslands, crops	11 04 01						**S**		(2)

(1) The methodology allows calculation of NH_3-emissions with particles stemming from stubble burning only.
(2) These emissions have to be reported under 10 01!

Table 2: Classification of activities according to EMEP/CORINAIR (2001) and attribution to SNAP 97 (2001): ***gases from animal metabolic processes***

Category	Activity	SNAP	NH_3	N_2O	NO	CH_4	NM VOC	PM	Remarks
Methane emissions from animal husbandry (Enteric fermentation)	Dairy cows	10 04 01				**S**			(1)
	Other cattle	10 04 02				**S**			
	Sheep	10 04 03				**S**			
	Fattening pigs	10 04 04				**S**			
	Horses	10 04 05				**S**			
	Mules and asses	10 04 06				**S**			
	Goats	10 04 07				**S**			
	Laying hens	10 04 08							
	Broilers	10 04 09							
	Other poultry	10 04 10							
	Fur animals	10 04 11							
	Sows	10 04 12				**S**			
	Camels	10 04 13							
	Buffalo	10 04 14							
	Any other animals	10 04 15							

(1) In previous Guidebook editions, chapter 10 04 dealt with CH_4 emissions both from enteric fermentation and from manure storage.

Table 3: Classification of activities according to EMEP/CORINAIR (2001) and attribution to SNAP 97 (2001): ***gases from manure management***

Category	Activity	SNAP	NH_3	N_2O	NO	CH_4	NM VOC	PM	Remarks
Manure management Regarding Organic Compounds	Dairy cows	10 05 01				**S, D**	**FE**		(1)
	Other cattle	10 05 02				**S, D**	**FE**		
	Fattening pigs	10 05 03				**S, D**	**FE**		
	Sows	10 05 04				**S, D**	**FE**		
	Sheep	10 05 05				**S**			
	Horses	10 05 06				**S**			
	Laying hens	10 05 07				**S**			
	Broilers	10 05 08				**S**			
	Other poultry	10 05 09				**S**			
	Fur animals	10 05 10							
	Goats	10 05 11				**S**			
	Mules and asses	10 05 12							
	Camels	10 05 13							
	Buffalo	10 05 14							
	Any other animals	10 05 11							
Manure management Regarding Nitrogen Compounds	Dairy cows	10 09 01	**S, I, D**	**S**	**S**				(2, 3)
	Other cattle	10 09 02	**S, I, D**	**S**	**S**				
	Fattening pigs	10 09 03	**S, I, D**	**S**	**S**				
	Sows	10 09 04	**S, D**	**S**	**S**				
	Sheep	10 09 05	**S, D**	**S**	**S**				
	Horses	10 09 06	**S, D**	**S**	**S**				
	Laying hens	10 09 07	**S**	**S**	**S**				
	Broilers	10 09 08	**S, D**	**S**	**S**				
	Other poultry	10 09 09	**S, D**	**S**	**S**				
	Fur animals	10 09 10	**S**						
	Goats	10 09 11							
	Mules and asses	10 09 12							
	Camels	10 09 13	**S**						
	Buffalo	10 09 14	**S**						
	Any other animals	10 09 15							

(1) Organic compounds include CH_4 and NMVOC. For the detailed methodology see Tier 2 in IPCC (1997, 2999).

(2) A method is considered *detailed* if it follows the pathway of N in detail. If it makes use of combined partial emission factors only, it is called *improved*.

(3) SNAP 10 09 has been reallocated in 2002, in line to changes to NFR. It now mirrors the 10 05 ordering.

Table 4: Classification of activities according to EMEP/CORINAIR (2001) and attribution to a preliminary SNAP code: ***particulate matter (primary particles) from agriculture and their constituents***

Category	Activity	SNAP	PM (mass)	Const. 1	Const. 2	....	....	....	Re-marks
Particulate matter	Housed livestock	10 10 00							
	Free range livestock	10 10 10							
	Feed management on farm	10 10 20							
	Plant production	10 10 30							

3 DETAILS – AGRICULTURAL EMISSIONS TO BE REPORTED IN GROUP 10

3.1 Subgroups 10 01 (Cultures with Fertilizers) and 10 02 (Cultures without Fertilizers)

Subgroups 10 01 and 10 02 are to be assigned to all emissions (except those of CO_2) originating from agricultural plants themselves or from their supporting soils.

As far as emissions from NO_x, N_2O and NH_3 are concerned, the basic difference between subgroups 10 01 and 10 02 is that for the latter only unintentional fertilization is taken into account whilst for subgroup 10.01 both intentional as well as unintentional fertilization are considered, each of these two categories being specified as follows:

Intentional fertilization comprises:

- Synthetic (mineral) fertilizer;
- Natural inorganic fertilizer;
- Organic manure (farmyard manure);
- Compost (either from municipal solid waste or sewage sludge).

Note that NH_3 emissions from the plant/soil system which take place during and after spreading, are covered by SNAP 10 90.

Unintentional fertilization means:

- Biological nitrogen fixation;
- Manure excreted by grazing animals;
- N input with atmospheric deposition resulting from NO_x and NH_3 emissions from agricultural plants and soil; and
- Crop residue application (this last category is defined to be unintentional for ease of emission estimation).

Note that indirect N_2O emissions due to N leaching/run-off from (intentional) fertilization are calculated and reported under indirect emissions in SNAP10 02.

CH_4 emission generating activities are associated only with rice fields and described under codes 10 01 03 and 10 02 03.

CH_4 consumption (oxidation by methanotrophic soil micro-organisms) is estimated.

NMVOC emissions occur both in fertilized and unfertilized systems. In this Guidebook, algorithms to estimate them are given in SNAPs 10 01 and 11 04 (Other Sources and Sinks) together with emissions from natural vegetation. However, they have to be reported under Cultures with Fertilizers (SNAP 10 01).

3.2 Subgroup 10 03 (on field burning of stubble, straw,...)

As suggested above this subgroup is proposed to cover all emissions originated from burning of agricultural vegetation-wastes, excluding those of agricultural non-vegetation wastes and also of wood wastes.

The methodology proposed in the IPCC Guidelines gives guidance for estimation emissions of NO_x, CH_4, CO and N_2O (and of CO_2 from C burnt). Nevertheless, emissions estimates could additionally be obtained for SO_2, NMVOC, and NH_3 using the methodology described in chapter 11 03 (forest fires) as the emissions factors for the latter three gases are there related to the mass of C burnt, per unit of residue mass burnt. The implied assumption in this methodological extension is that burning of agricultural wastes could be treated similarly to forest fires, at least for CH_4, CO and N_2O.

3.3 Subgroups 10 04 (Enteric Fermentation)

So far, the calculation of CH_4 emissions due to enteric fermentation follow the Tier 1 approach of the IPCC Guidelines. Reference is made to the respective Tier 2 approaches of the IPCC Guidelines.

In previous editions of the Guidebook, SNAP 1040 included the treatment of CH4 emissions from manure management.

3.4 10 05 and 10 09 (Manure Management Regarding Organic and Nitrogen Compounds)

The subgroups deal with emissions of all gaseous carbon nitrogen species (NH_3, N_2O, NO) from animal husbandry as a whole following the mass flow approach.

For CH_4, the IPCC Tier 1 and Tier 2 methodologies are taken over.

A tool to estimate the order of magnitude of NMVOC emissions from stored manure is provided.

For NH_3, the calculation procedures given in this chapter include emissions from grazing animals, which have to be reported under 10 01 (Cultures with fertilizer). Note that grazing of “hill sheep” would have to be reported under 10 02 (Cultures without fertilizer), but (at present) the emission factor is zero. Direct NH_3 emissions from manure and slurry applied to soil and plant canopies are to be reported under 10 09, whereas indirect emissions of N_2O and NO resulting from these NH_3 emissions have to be reported under 10 02 (Cultures without fertilizers).

3.5 Subgroup 10 06 (Use of Pesticides and Limestone)

At present, a simpler methodology is given for the assessment of emissions from the application of limestone and pesticides. For limestone, this is at the same time the best available approach.

3.6 Subgroup 10 10 (Emissions of Primary Particles PM_{10}) [1]

Agricultural sources may emit particles directly. Both their size (particle diameter and shape) and the composition (element and species composition, active biological material such as bacteria) are interesting properties. In a first step, the chapter under preparation will deal with physical properties and classify particles accordingly (total suspended matter, TSP; particulate matter with an aerodynamic diameter < 10 µm, PM_{10}; particulate matter with an aerodynamic diameter < 2.5 µm, $PM_{2.5}$).

4 AGRICULTURAL ACTIVITIES NOT TO BE REPORTED IN GROUP 10

Sector specific emissions from agriculture or related to agriculture include sources which are not listed under chapter 10. These are covered in the Guidebook sections 02, 08 and 09.

4.1 Non-industrial Combustion Plants

A subgroup is reserved for all stationary combustion sources in the agriculture, forestry and aquaculture:

02 03	**Plants in agriculture, forestry and aquaculture**
02 03 01	Combustion plants >= 50 MW (boilers)
02 03 02	Combustion plants < 50 MW (boilers)
02 03 03	Stationary gas turbines
02 03 04	Stationary engines
02 03 05	Other stationary equipment

4.2 Off-road Transport

The internal combustion engines used in agriculture will be dealt with in a special subgroup.

08 06	**Agriculture**
08 06 01	2-wheel tractors
08 06 02	Agricultural tractors
08 06 03	Harvesters / combines
08 06 04	Others (sprayer, manure distributors, agricultural mowers, balers, tillers, swatchers)

At present, methods are given in chapter 08 10 00.

[1] The proposed SNAP 10 10 is new, created in 2001/02 in order to accommodate the need for reporting (under NFR) PM emissions from agricultural activities not yet covered by the existing SNAP definitions.

4.3 Open Burning of Agricultural Wastes (Except Stubble Burning)

Though the title of section 09 is misleading, open burning of (organic) agricultural wastes with the exception of those items covered by 10 03 is dealt with in subgroup 09 07. A (very) simple methodology is given, which includes:

- Crop residues (cereals, crops, peas, beans, soy, sugar beet, oil seed rape etc.);
- Wood;
- Leaves;
- Animal carcasses (unless they are incinerated under controlled conditions, see Chapter 09 09 02);
- Plastics;
- Poultry and animal excreta (unless they are burnt under controlled conditions);
- Vegetation wastes except stubble, straw (covered within subgroup 10 03).

4.4 Other Sources or Sinks – Agriculture under Natural or Semi-natural Conditions

As mentioned above, extensive agriculture may make use of natural or semi-natural grassland or low vegetation, and is then to defined non-agricultural (see above).

11 04	**Natural grasslands and other vegetation**
11 04 01	Grassland
11 04 02	Tundra
11 04 03	Other Low vegetation
11 04 04	Other vegetation (Mediterranean scrub,…)

It is advisable that for the purpose of reporting definitions are made and justified in order to guarantee comparability of results.

5 NFR AND NOSE CODES

References are made to other codes used within the UNECE reporting system at the beginning of each chapter (at least when they are next updated). Besides, correspondence tables relating SNAP to IPCC and (at the same time) NFR coding are provided in Part B (Background), Chapter BSVI, of the Guidebook.

6 REFERENCES

Dämmgen U, Menzi H, Webb, J (2003) Background on Ammonia (and other Gaseous) Emissions from Agriculture. Workshop on "Inventories and Projections of Greenhouse Gas and Ammonia Emissions from Agriculture". 27 to 28 February 2003, EEA, Copenhagen. Inventory and Projections Experts Workshop under Working Group I and Working Group II of the EU GHG Monitoring Mechanism Committee. http://air-climate.eionet.eu.int/docs/meetings/030227_AgricEmiss/3_Backgrnd_Agric_Em_NH3_Ulrich_Daemmgen.pdf.

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7 RELEASE VERSION, DATE AND SOURCE

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