Sector 3 Agriculture

Jana Beranová
IFER – Institute of Forest Ecosystem Research, Ltd.

2021

Agenda

- Overview (Agriculture in CR, agricultural sector in NIR)
- Emissions trends
- Emission estimation „per partes“ 3A, 3B, 3D, 3H, 3G (AD, methods, results)
- QA/QC sectoral specifications
- Questions, discussion

Overview of the Agriculture in CR

- Agriculture land: 53 % of country area
- Arable land: 40 % of country area
- Country is the self-sufficient in beef, milk, cereals, sugar and beer production.
- 72 % of the agricultural land is rented
- Low share of small farms (farms with less than 50 ha occupy 9 % agricultural land only)
- 1.6 % is the share of Agriculture on GDP
- 241 th. total workers, only 174 th. full time jobs in agriculture

Historical overview

- 1989 - collapse of communistic regime, start of market economy
- since 1990s - transformation and adaptation of the agricultural sector to the new economic conditions
- 2004 onwards - Czech entrance to EU, acceleration of coordination of the national agricultural policy with EU
- Rural Development Program and subsidies:
  2007-2013 (closed), 2014 – 2020 (still running)
- + „Direct payment“ policy (30% are linked to greening: crop diversification, maintaining of permanent grassland and conserving environmental valuable plots)

Overview of the sector

6.5 % of total GHG emissions in 2019 (excl. LULUCF)

29 % total national emissions of CH_4 (excl. LULUCF)

76 % total national emissions of N_2O (excl. LULUCF)

Emissions trend:

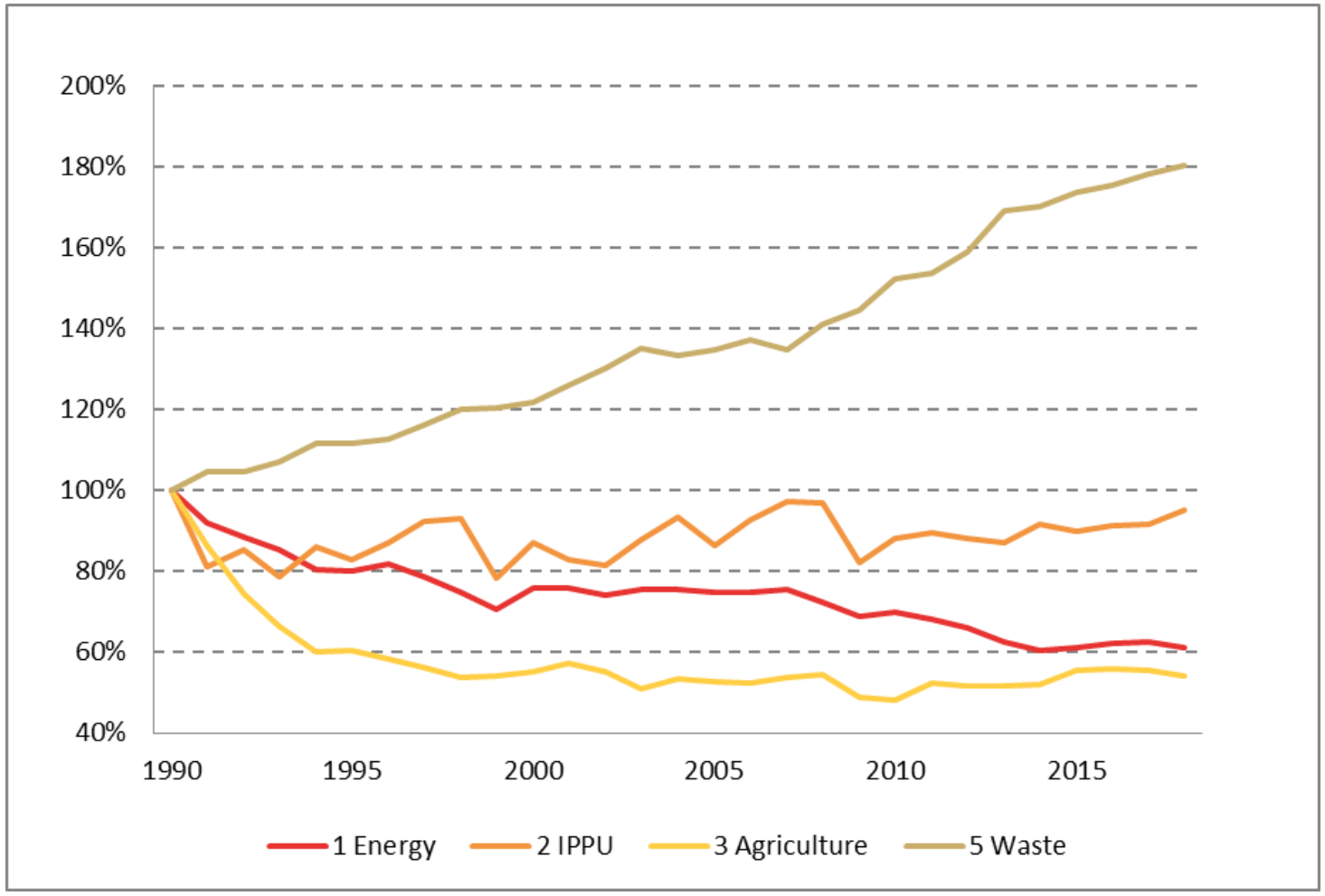
- Reduction around 50 **%** in period 1990-2010
- Fluctuation ± 10 %, since 1997 till now
- Forecast 2019 +: steady state or downward trend **due to methodological update**

Year	**Gg CO_2 eq.**	**Relative expression**
1990	15 712	100 %
2010	7 558	48 %
2015	8 741	56 %
2019	8 199	52 %

Overview of significant categories

Category	Gas	KC A2	% of total GHG excl. LULUCF
3.D.1 Agricultural soils, Direct N_2O emissions	N_2O	LA, TA	2.38
3.A Enteric Fermentation	CH_4	LA, TA	2.37
3.D.2 Agricultural soils, Indirect N_2O emissions	N_2O	LA, TA	0.72
3.B Manure management	N_2O	LA, TA	0.36
3.B Manure management	CH_4	TA	0.42
3.G Liming	CO_2	TA	0.16

Emission trends in 1990-2019 by categories (NIR, submission 2021)



Overview of the sector (submission 2019)

Source of emission:

Enteric Fermentation (CH_4)

Manure Management (CH_4 and N_2O)

Agricultural Soils (N_2O)

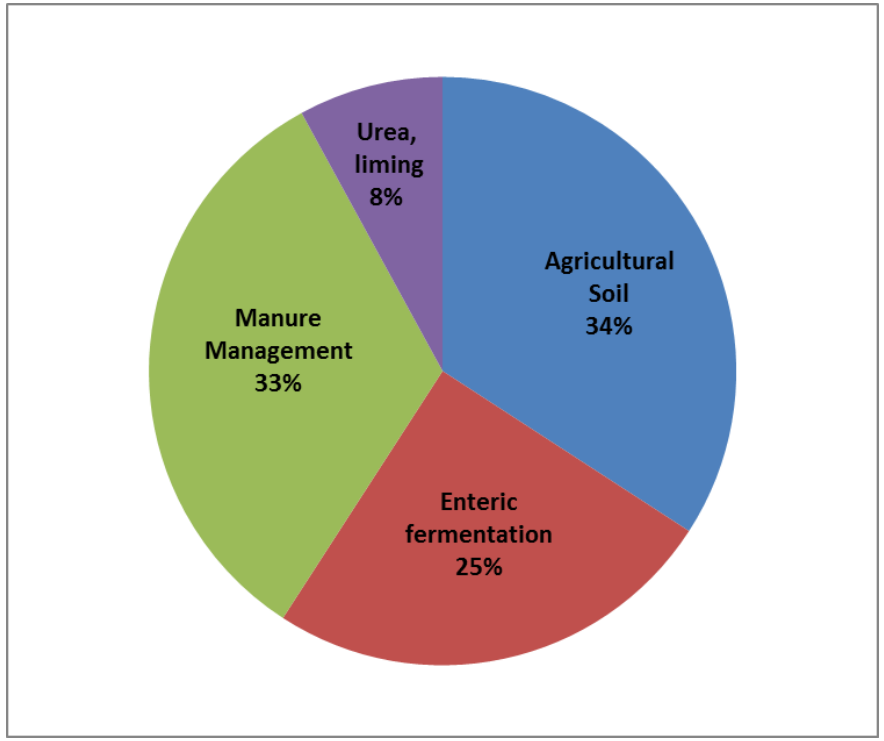
Liming and Urea consumption (CO_2)

Not occuring:

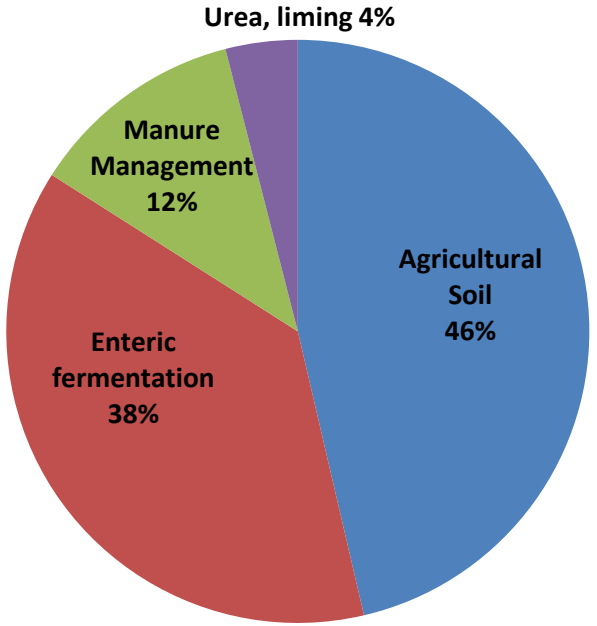
- Rice cultivation
- Prescribed burning of savannas
- Field burning of agricultural residues
- and „Other“
- + buffalo, lamas, mules etc.

Portion of emissions sources in agricultural sector

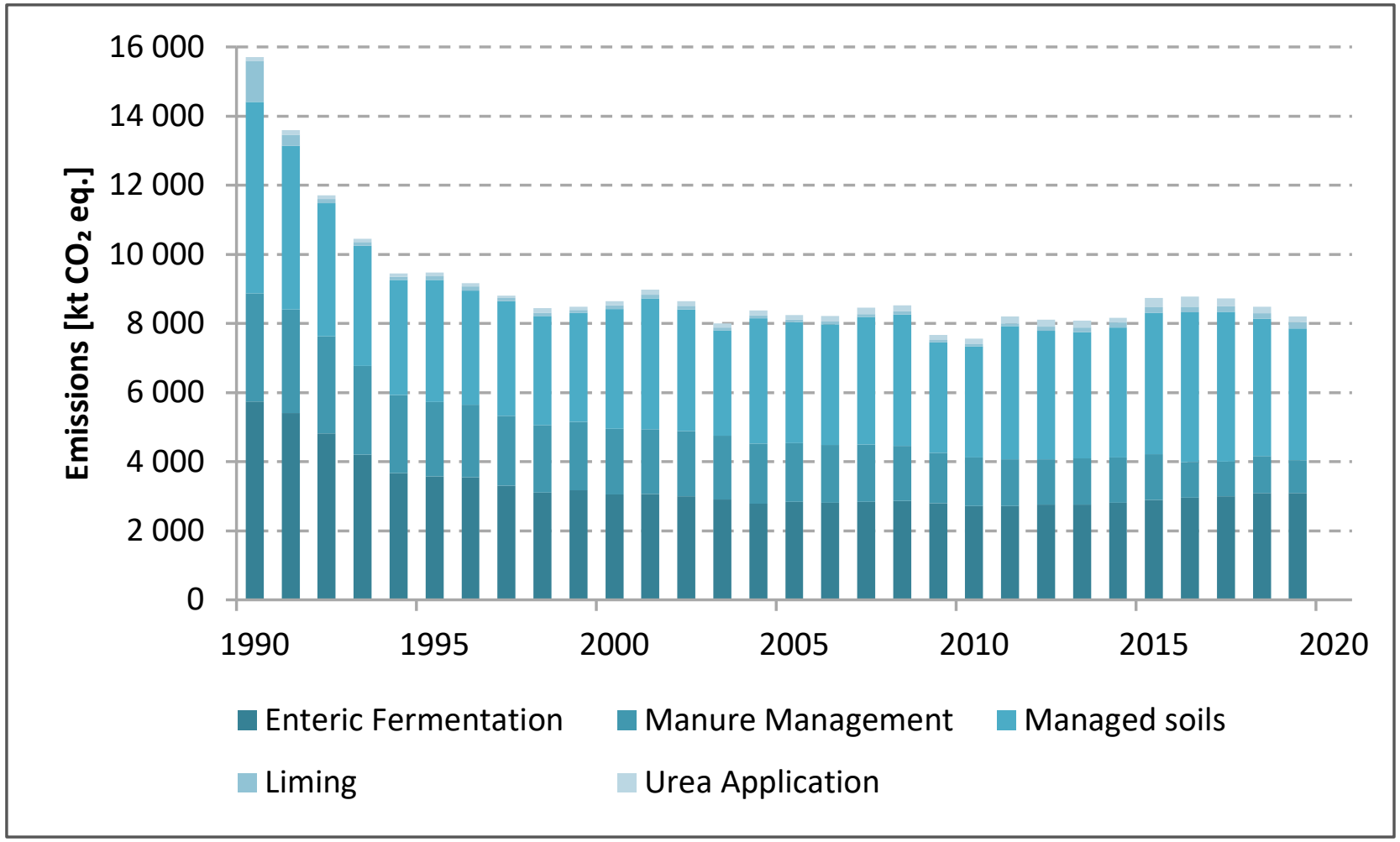
1990, the base year



2019, submission 2021



The emission trends in agricultural sector during 1990-2019 (in Gg CO_2 eq.)



Emission trends explanation

- Reduction of animal population, comparison current data with data from 90s: swine population 35 %
  cattle population 40 %

  3 532 th. cattle in 1990,

  1 415 th. cattle in 2019

- Reduction of amount of nitrogen fertilizers by about 50 %, increase since 2010

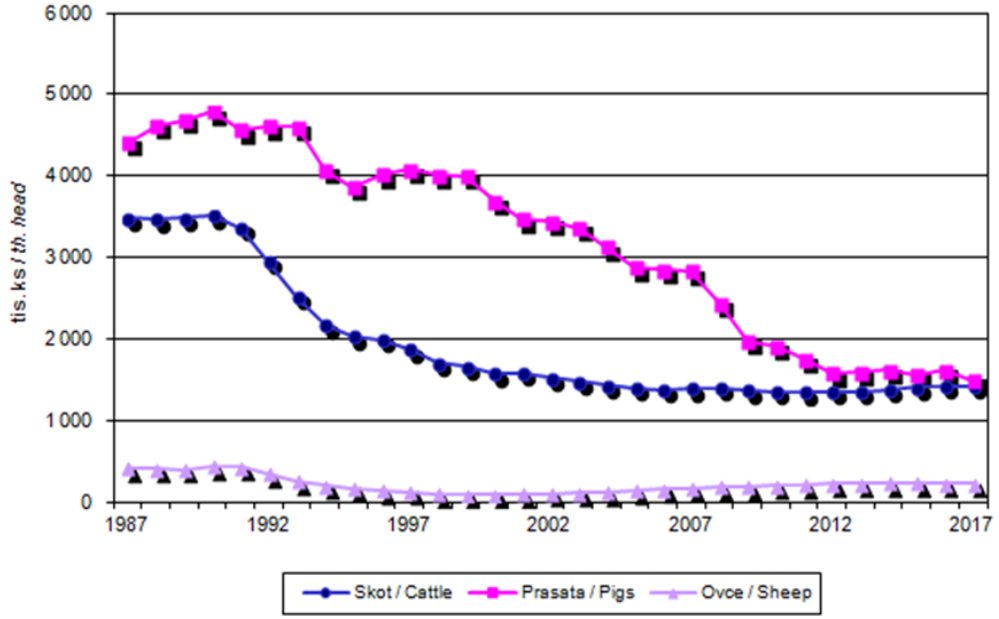
  418 144 t N in 1990,

  221 668 t N in 2009,

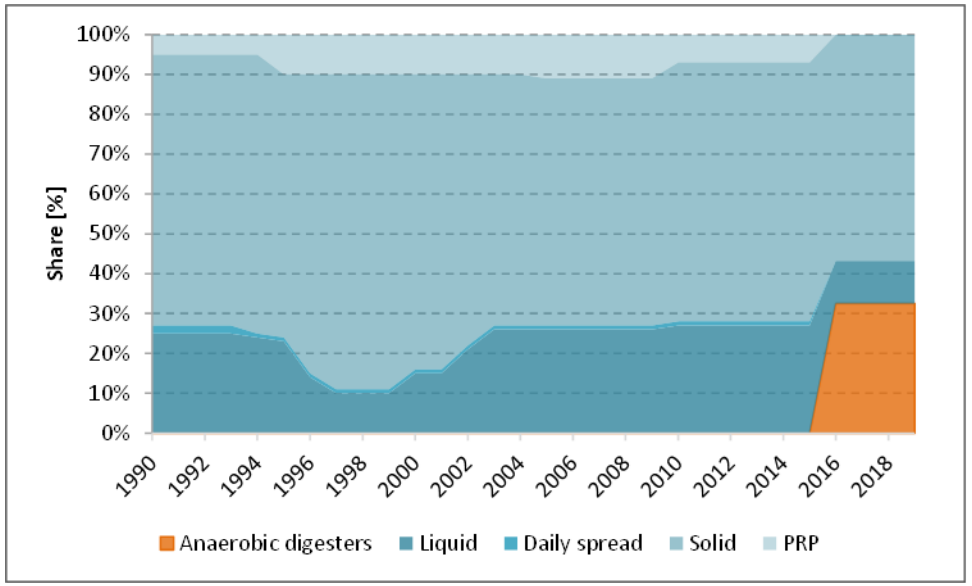
  332 023 t N in 2019

- AWMS update several times, anaerobic digesters included since 2016

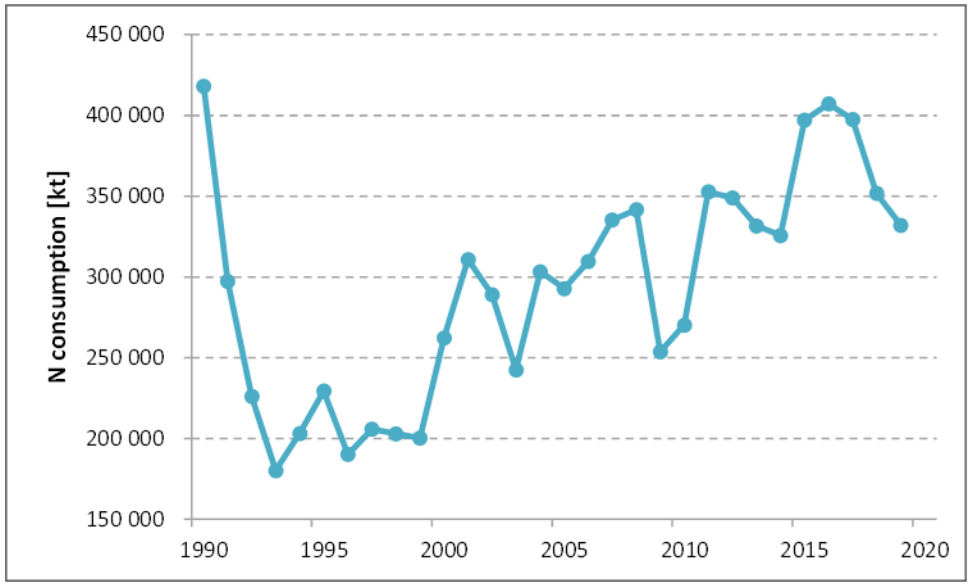
Vývoj stavů hospodářských zvířat v ČR v letech 1987 - 2017
Livestock in the Czech Republic: time series 1987-2017



Development of Manure Managements systems share used for calculations, dairy cattle



Consumption of N from synthetic fertilizers (kt) during reporting period (1990-2019)



Time schedule of the new submission

March/April/May – sector expert decision about updates

- Improvement plan realization, looking for new possibilities, communication, studying

May/June – proxy inventory – data collection, technical maintenance of spreadsheets

July, August – review of the previous submission, new inspiration, corrective action in spreadsheets

**October, November - ** activity data collection, emissions calculation, loading data to CRF and back, QA/QC

December/January/February – new submission, reporting, beginning of the new review process

Generally about methods in the Czech NIR

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 10 and 11
- Relevant national studies focused on key points of the inventory, data inputs and higher level of methodologies
- Consultancy and personal communication with other subjects working in international reporting and relevant research in Agri sector:

  EUROSTAT/OECD (Nitrogen balance in Agri),

  FAOSTAT,

  Reporting of air pollutants in Agri (NH3, NOx)

  Cattle breeding/feed specialist etc.
- Methodological advices and recommendations from review's teams
- Consultations with EU experts, studying of NIR reports of other countries and thematic reports (UNFCCC, JRC, FAO etc.)

Banja, M., Crippa M, : (2020): Methodological overview on the calculation of air pollutant and greenhouse gas emissions form agricultural activities, *EUR* 30338 EN, Publications Office of the EU, Luxembourg, 2020, ISBN 978-92-76-25423-2, 68 pp.

Wilkes, A, van Dijk, S. (2018). Tier 2 inventory approaches in the livestock sector: a collection of agricultural greenhouse gas inventory practises. UNIQUE. November 2018

FAO, GRA. 2020. Livestock Activity Data Guidance(L-ADG): Methods and guidance on compilation of activity data for Tier 2 livestock GHG inventories. New Zealand: Food and Agriculture Organization of the United Nations and Global Research Alliance on Agricultural Greenhouse Gases. https://doi.org/10.4060/ca7510en

Haenel H-D, Rösemann C, Dämmgen U, Döring U, Wulf S, Eurich-Menden B, Freibauer A, Döhler H, Schreiner C, Osterburg B, Fuß R (2020) Calculations of gaseous and particulate emissions from German agriculture 1990 – 2018 : Report on methods and data (RMD) Submission 2020. Braunschweig: Johann Heinrich von Thünen-Insti tut, 448 p, Thünen Rep 77, DOI:10.3220/REP158436370800

Lagerwerf, L.A., A. Bannink, C. van Bruggen, C.M. Groenestein, J.F.M. Huijsmans, J.W.H. van der Kolk, H.H. Luesink, S.M. van der Sluis, G.L. Velthof & J. Vonk (2019). Methodology for estimating emissions from agriculture in the Netherlands. Calculations of CH4, NH3, N2O, NOx, NMVOC, PM10, PM2.5 and CO2 with the National Emission Model for Agriculture (NEMA) – update 2019. Wageningen, The Statutory Research Tasks Unit for Nature and the Environment. WOt-technical report 148. 215 p.; 6 Figs; 45 Tabs; 108 Refs; 12 Annexes

Generally about Activity data

1. Default data from IPCC GL 2006

Cool climate, annual average temperature <10 (7.8 ^{o}C)

Developed country

Western Europe

Example: N2O emissions factors, methane conversion factor,
CO2 emission factors, Frac Loss (to soil), Frac GASMS (indirect), etc

2. Country specific

Well documented

Example: Nex rate (Decree), AWMS (shared data with other reporting), number of livestock (CSU), Crops yield (CSU), N in mineral fertilizers (MoA)

Expert judgement

Example: Digestibility of cattle feed, share of digestate generated from manure

Calculated – suitable input data available

Example: methane emission factor for enteric fermentation in cattle category
methane emission factor for manure management in swine category

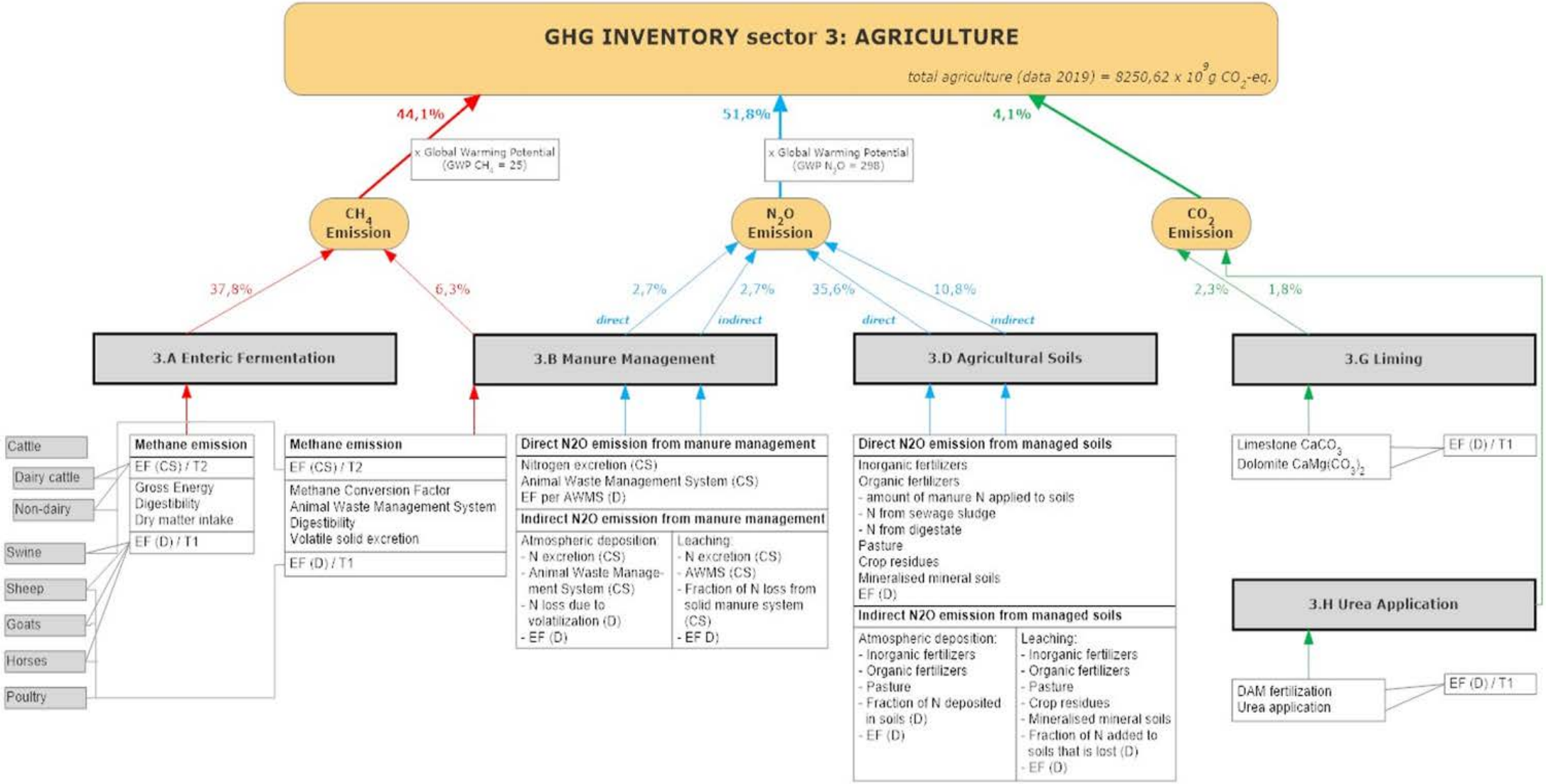
D42

	A	B	C	D	E	F	H	
1	**Activity data**	**Unit**	**Data sources NIR (Submission 2022)**	**Reference to relevant sheet**	**Animal category**	**AWMS**		
2					**NonDairy**	**AnaerobicLagoon**	**1990**	
3	Weight	kg	Decree 377/2013 Col.	Cattle	NonDairy	NA	NA	NA
4	Feeding situation	%	CS, for cattle only	Dairy, Non - Dairy, D.	NonDairy	NA	20.41	
5	Milk yield	kg/day	Annual book of Cattle breeding (for cattle only)	Dairy, Non - Dairy, D.	NonDairy	NA	NO	NO
6	Work	hours/day	CS (for cattle only)	Dairy, Non - Dairy, D.	NonDairy	NA	NO	NO
7	Pregnancy	%	CS (for cattle only).,expert opinion	Dairy, Non - Dairy, D.	NonDairy	NA	1.17	
8	Digestibility of feed	%	CS (for cattle only), expert opinion	Dairy, Non - Dairy, D.	NonDairy	NA	65.00	
9	Gross Energy Intake	MJ/head/day	Calculated on dedicated application, IPCC GL T2 (for cattle only)	CattleDairy, Non -	NonDairy	NA	115.99	
10	Population size	1000 head	CZSO	Cattle, Swine, Poultry,	NonDairy	NA	2300.00	
11	Average CH4 conversion rate (Ym)	%	Default value, IPCC GL 2006 (T.10.12, for cattle only)	Dairy, Non - Dairy, D.	NonDairy	NA	NA	NA
12	Manure allocation by climate	%	CS, CHMI	Dairy MM, Non-	NonDairy	NA	100.00	
13	VS daily excretion	kg dry mass/head/day	Decree 377/2013 Col. (for swine), Calculated on dedicated application, IPCC GL T (for cattle only)	D.applications, cattle,	NonDairy	NA	2.26	
14	N excretion rate	kg N /head/yr	VÚRV, based on Decree 377/2013 Col., annual update	Cattle, Dairy MM,	NonDairy	NA	54.55	
15	N excretion per MMS	kg N/yr	VÚRV, annual update	AWMS per animal,	NonDairy	AnaerobicLagoon	NO	NO
16	Total N excreted	kg N/yr	Calculated, IPCC GL 2006	AWMS per animal,	NonDairy	AllAWMS	125456228.45	1
17	Total N volatilized from MM as NH3 and NOx	kg N/yr	Calculated, IPCC GL 2006, Frac GASMS (T.10.22)	AWMS_animals ,	AllAnimals	AllAWMS	127233989.71	1
18	Emission factors for CH4: Enteric fermentation	kg CH4/head/yr	Calculated on dedicated aplication (cattle), IPCC GL 2006 (T.10.10)	Dairy, Non-Dairy,	NonDairy	NA	43.57	
19	Emission factors for CH4: Manure management	kg CH4/head/yr	Calculated on dedicated aplication (cattle, swine), IPCC GL 2006 (T.10.15)	Dairy MM, Non-	NonDairy	NA	7.87	
20	Limestone and Dolomite used as fertilizers in Agri amf Forestry	kg CO2/ year	MoA, VÚRV	Liming	NA	NA	1187.63	
21	Urea and DAM used as ferilizers	kg CO2/ year	MoA, VÚRV	Urea	NA	NA	108.53	
22	Inorganic N fertilisers	kg N/yr	MoA, VÚRV	Direct	NA	NA	418144000.00	2
23	Organic N fertilisers a. Animal manure applied to soils	kg N/yr	Calculated, IPCC GL 2006, Frac LOSSMS (T.10.23)	Direct	NA	NA	180112684.41	1
24	Organic N fertilisers b. Sewage sludge applied to soils	kg N/yr	CZSO	Direct (Sewage)	NA	NA	253139.20	
25	Organic N fertilisers c. Other organic fertilisers applied to soils	kg N/yr	VÚRV (digestate from animal manure)	Direct	NA	NA	NO	NO
26	Urine and dung deposited by grazing animals	kg N/yr	VÚRV, annual update	PRP	NA	NA	29037333.30	
27	Crop residues	kg N/yr	IPCC GL 2006, T1 , CZSO	Direct	NA	NA	249373928.91	2
28	Atmospheric deposition - amount of nitrogene volatilized from MM	kg N/yr	Calculated IPCC GL, T1	Indirect	NA	NA	83695031.38	
29	Leaching and run-off - amount of nitrogene leaching and run off from MM	kg N/yr	Calculated IPCC GL, T1	Indirect	NA	NA	264616838.41	2
30	Emission factors for direct N2O emissions: Manure management	kg N2O-N/kg N excreted/yr	IPCC GL 2006, T. 10.21	Manure Management,	NonDairy	AnaerobicLagoon	0.000	
31	Indirect emission from MM: Emission factor for atmospheric deposition EF4	kg N2O-N/kg N volailized/yr	IPCC GL 2006, T. 11.3	AWMS per animals	NA	NA	0.0100	
32	Fraction of nitrogen loss from MM	Fraction	IPCC GL 2006, T. 10.23	AWMS per animals	NonDairy	AnaerobicLagoon	0.23	
33	Indirect emission form MM for Leaching and Run-off (F5)	kg N2O-N/kg N leaching-runoff/yr	IPCC GL 2006, T. 11.3	AWMS per animals	NA	NA	0.0075	
34	Fraction of nitrogen from MM leached and runoff	Fraction	CS	AWMS per animal,				
35	Emission factors for direct N2O emissions from agricultural soils	kg N2O-N/kg N	IPCC GL 2006, T. 11.1	Direct, PRP	NonDairy	SynthFertil	NA	NA
36	Indirect emission from soils: Emission factor for atmospheric deposition EF4	kg N2O-N/kg N volailized/yr	IPCC GL 2006, T. 11.3	Indirect	NA	NA	0.0100	
37	Indirect emission from soils for Leaching and Run-off (F5)	kg N2O-N/kg N leaching-runoff/yr	IPCC GL 2006, T. 11.3	Indirect	NA	NA	0.0075	
38	Fraction of N from anorganic fertilisers applied that volatilizes as NH3 and NOx	Fraction	Default value, IPCC GL 2006, T.11.3	Indirect	NA	NA	0.1000	
39	Fraction of N of all organic fertilizers volatilized as NH3 and NOx	Fraction	Default value, IPCC GL 2006, T.11.3	Indirect	NA	NA	0.2000	
40	Fraction of N loss by leaching/runoff volatilized as NH3 and Nox	Fraction	Default value, IPCC GL 2006, T.11.3	Indirect	NA	NA	0.3000	
41								
42								
43								
44								
45								
46								

Index | Activity data overview | Agri | Ent Ferm | Cattle | Dairy cattle | Non-dairy | Sheep | swine | poultry | goats | horses | Manure Manag | Cattle MM | Dairy MM | Non-dairy MM | Sheep MM | Goats MM | Horses MM | Swine MM | Poult ...

Type here to search

1°C Fog CES 11:27 10/11/2021


GHG INVENTORY sector 3: AGRICULTURE
total agriculture (data 2019) = 8250,62 x 10^9 g CO2-eq.
44,1%
51,8%
4,1%
x Global Warming Potential (GWP CH4 = 25)
x Global Warming Potential (GWP N2O = 298)
CH4 Emission
N2O Emission
CO2 Emission
37,8%
6,3%
2,7%
2,7%
35,6%
10,8%
direct
indirect
direct
indirect
2,3%
1,8%
3.A Enteric Fermentation
3.B Manure Management
3.D Agricultural Soils
3.G Liming
3.H Urea Application
Cattle
Dairy cattle
Non-dairy
Swine
Sheep
Goats
Horses
Poultry
Methane emission
EF (CS) / T2
Gross Energy
Digestibility
Dry matter intake
EF (D) / T1
Methane emission
EF (CS) / T2
Methane Conversion Factor
Animal Waste Management System
Digestibility
Volatile solid excretion
EF (D) / T1
Direct N2O emission from manure management
Nitrogen excretion (CS)
Animal Waste Management System (CS)
EF per AWMS (D)
Indirect N2O emission from manure management
Atmospheric deposition:
- N excretion (CS)
- Animal Waste Management System (CS)
- N loss due to volatilization (D)
- EF (D)
Leaching:
- N excretion (CS)
- AWMS (CS)
- Fraction of N loss from solid manure system (CS)
- EF D)
Direct N2O emission from managed soils
Inorganic fertilizers
Organic fertilizers
- amount of manure N applied to soils
- N from sewage sludge
- N from digestate
Pasture
Crop residues
Mineralised mineral soils
EF (D)
Indirect N2O emission from managed soils
Atmospheric deposition:
- Inorganic fertilizers
- Organic fertilizers
- Pasture
- Fraction of N deposited in soils (D)
- EF (D)
Leaching:
- Inorganic fertilizers
- Organic fertilizers
- Pasture
- Crop residues
- Mineralised mineral soils
- Fraction of N added to soils that is lost (D)
- EF (D)
Limestone CaCO3
Dolomite CaMg(CO3)2
EF (D) / T1
DAM fertilization
Urea application
EF (D) / T1

Methodological level

3A Enteric fermentation, cattle (Tier 2)

3A Enteric fermentation, other livestock (Tier 1)

3B1 CH4 emissions from manure, cattle, swine (Tier 2)

3B1 CH4 emissions from manure, other livestock (Tier 1)

Manure management system (country specific)

Nex rate, all animals (country specific)

3B2 Direct N2O emission from manure (Tier 1 and Tier 2 – CS Nex + AWMS)

3B2 Indirect N2O emission from manure (Tier 1 and 2 – CS Nex and FracLeachMS)

3D Direct emission from soils (Tier 1)

3D Indirect emissions from soils (Tier 1)

3H Urea aapplication (Tier 1)

3G Liming (Tier 1)

3A Enteric fermentation, cattle, Tier 2

- Separate spreadsheet for calculation of EFs, based on national study (Kolar et. al, 2004)
- Czech country-specific data for estimation of methane emissions from enteric fermentation of cattle (Hons and Mudrik, 2003, expert data update 2010, just working on the new update)
- 10 subcategories, 10 sets of activity data
- Two reported categories – dairy cattle, other cattle (outputs are WA of results from individual categories)

- Overview of AD …….

Parameter	Description	Data source
Animal Population	10 subcategories, gender, age, production systém	Czech Statistical Office
Body weight	Average body weight by cattle categories	Expert opinion, since 2016 Decree 377/2013 Sb.
Mature weight	Weight of mature animal by categories in kg. According definition it is weight of mature animal withoult last feed (96%).	Expert opinion, since 2016 Decree 377/2013 Sb
Weight gain	Average daily weight gain per animal subcategories, growing	Calculated with support of Decree 377/2013 Sb
Milk yield/	Average daily milk production kg/day	Yearbook of cattle breeding
Fat content of milk		Yearbook of cattle breeding
Fraction of Adults females pregnant	Dairy cattle and suckler cattle	Expert opinion
Feeding situation	Stall, pasture or paddock. Affects energy expenditure	Expert opinion
Feed digestability	The portion of gross energy in the feed not excreted (use for production, growth, movement)	Expert opinion
Fraction of manure managed in different management systems, AWMS	Portion od solid, liquid, pasture, and anaerobic digesters manure management systems	Expert opinion, since 2016 documented survey (Klír, 2018)
Crude protein content	Estimation of protein portion in feed per day	Tománková, O., Homolka, P., (2010):
Protein content of milk		Yearbook of cattle breeding

Input data example – body weight, cattle categories

Categories of cattle	1990 – 1994	1995 - 1998	1999 - 2004	2005 - 2009	2010 - 2015	2016 - now
Dairy cows	520	540	580	585	590	650
Sucklers	520	540	580	585	590	650
Heifers > 2 years	485	490	505	510	515	600
Bulls > 2 years	750	780	820	840	850	800
Heifers 1-2 years	380	385	395	395	390	470
Bulls 1-2 years	490	510	530	540	560	560
Heifers 6-12 months	275	280	285	285	290	265
Bulls 6-12 months	325	330	335	340	350	300
Calves' male to 6 months	128	132	133	135	135	115
Calves' female to 6 months	128	132	133	135	135	115

Input data development, *example – milk production*

- Daily milk production of dairy cows increased:
  - 10.67 l/day/head in 1990
  - 19.13 l/day/head in 2009
  - 23.86 l/day/head in 2019

- Fat content slightly decreased:
  - 4.03 % in 1990
  - 3.90 % in 2009
  - 3.98 % in 2019

Methan emissions from enteric fermentation

	Dairy cows	Other cattle	EF Dairy Cows	EF Other cattle	Emissions total
	[thous.]	[thous.]	[kg CH_4/hd]	[kg CH_4/hd]	[kt CH_4]
1990	1 206	2 300	97.80	43.57	218.88
1995	732	1 298	102.40	46.75	135.86
2000	548	1 026	114.04	51.38	115.14
2005	433	960	127.50	54.66	108.06
2010	384	966	133.97	54.22	103.71
2015	376	1031	145.15	54.65	104.07
2016	373	1043	148.67	55.73	105.49
2017	370	1051	150.39	56.69	105.46
2018	365	1050	155.53	59.25	107.75
2019	364	1053	156.36	58.82	110.90

3A Enteric fermentation, other livestock (Tier 1)

Emissions CH_4 (eq. 10.19): population * EF_p

Emission factors from Table 10.10 (kg CH_4 /head/year):

Sheep:	8
Goats :	5
Horses:	18
Swine:	1.5

Animal population from the Czech Statistical Yearbook

3B1 Methane emissions from manure management, cattle (Tier 2)

CH_4 production during decomposition of organic material by anaerobic bacteria under anaerobic conditions.

Specific spreadsheet for calculation of EFs, separately for each cattle category (country specific)

Main inputs - GE and DE from Enteric fermentation estimation

IPCC Good Practice Guidelines (Tier 2) procedures:
Eq. 10.23, 10.24, 10.22

B_0 : Table 10A-9,

MCF: Table 10.17, comparable with Daemmgen et al. 2012

3 B1 Methan emission from manure management, swine Tier 2

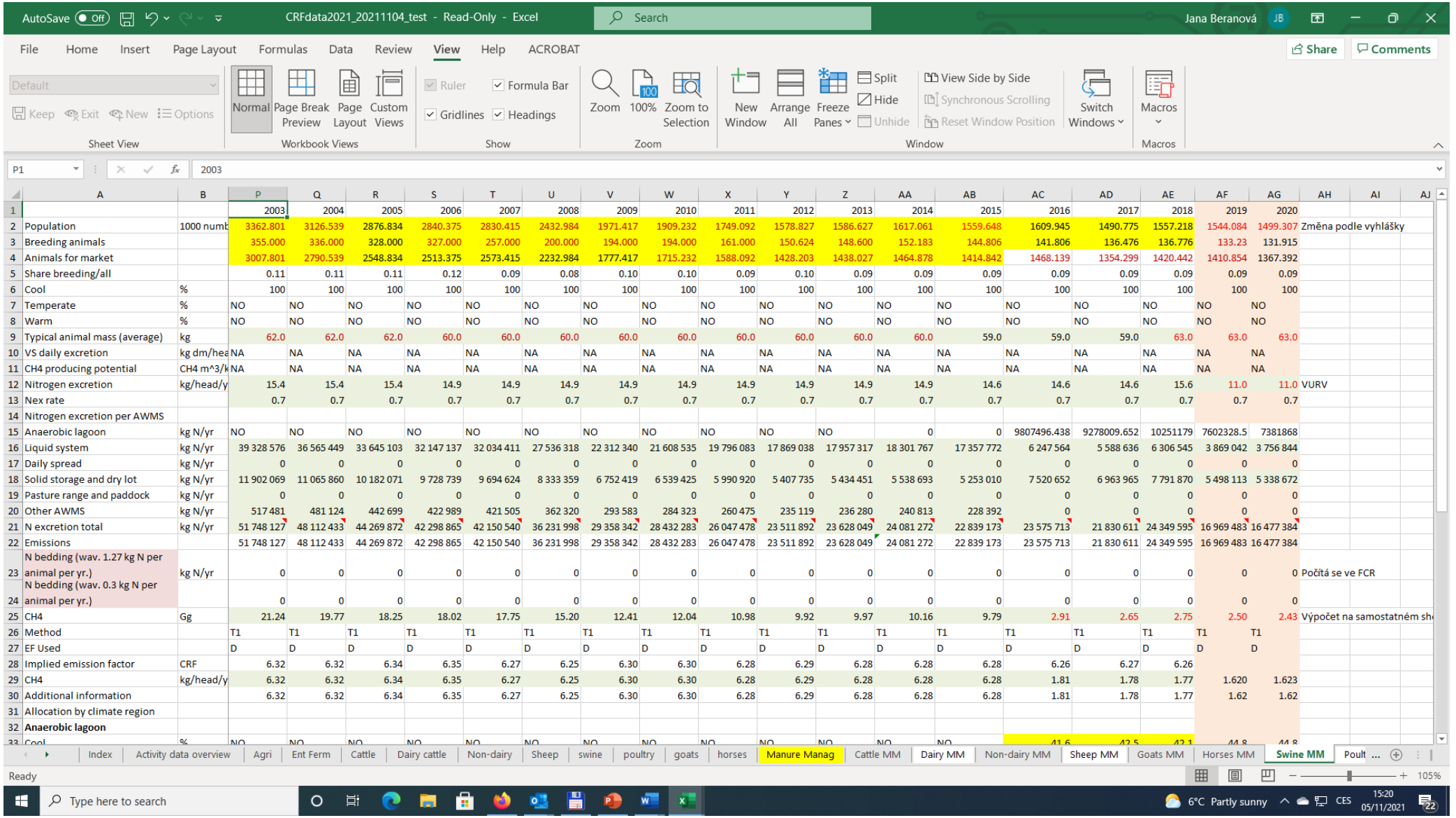
Update prepared for submisson 2022

Separate spreadsheet

Inputs:

- Swine population splits to 4 weight categories
- Production of manure per year/per animal (CS data)
- Production of dry matter in excretions (CS data)
- Methane conversion factor (AWMS * default), Bo (default)

Decrease of emission factor for more then 50 % !!!!



	A	B	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1			2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020			
2	Population	1000 numb	3362.801	3126.539	2876.834	2840.375	2830.415	2432.984	1971.417	1909.232	1749.092	1578.827	1586.627	1617.061	1559.648	1609.945	1490.775	1557.218	1544.084	1499.307	Změna podle vyhlášky		
3	Breeding animals		355.000	336.000	328.000	327.000	257.000	200.000	194.000	194.000	161.000	150.624	148.600	152.183	144.806	141.806	136.476	136.776	133.23	131.915			
4	Animals for market		3007.801	2790.539	2548.834	2513.375	2573.415	2232.984	1777.417	1715.232	1588.092	1428.203	1438.027	1464.878	1414.842	1468.139	1354.299	1420.442	1410.854	1367.392			
5	Share breeding/all		0.11	0.11	0.11	0.12	0.09	0.08	0.10	0.10	0.09	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09			
6	Cool	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100			
7	Temperate	%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO			
8	Warm	%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO			
9	Typical animal mass (average)	kg	62.0	62.0	62.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	59.0	59.0	59.0	63.0	63.0	63.0			
10	VS daily excretion	kg dm/hea	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
11	CH4 producing potential	CH4 m^3/k	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA			
12	Nitrogen excretion	kg/head/y	15.4	15.4	15.4	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.6	14.6	14.6	15.6	11.0	11.0	VURV		
13	Nex rate		0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7			
14	Nitrogen excretion per AWMS																						
15	Anaerobic lagoon	kg N/yr	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0	0	9807496.438	9278009.652	10251179	7602328.5	7381868			
16	Liquid system	kg N/yr	39 328 576	36 565 449	33 645 103	32 147 137	32 034 411	27 536 318	22 312 340	21 608 535	19 796 083	17 869 038	17 957 317	18 301 767	17 357 772	6 247 564	5 588 636	6 306 545	3 869 042	3 756 844			
17	Daily spread	kg N/yr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
18	Solid storage and dry lot	kg N/yr	11 902 069	11 065 860	10 182 071	9 728 739	9 694 624	8 333 359	6 752 419	6 539 425	5 990 920	5 407 735	5 434 451	5 538 693	5 253 010	7 520 652	6 963 965	7 791 870	5 498 113	5 338 672			
19	Pasture range and paddock	kg N/yr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
20	Other AWMS	kg N/yr	517 481	481 124	442 699	422 989	421 505	362 320	293 583	284 323	260 475	235 119	236 280	240 813	228 392	0	0	0	0	0			
21	N excretion total	kg N/yr	51 748 127	48 112 433	44 269 872	42 298 865	42 150 540	36 231 998	29 358 342	28 432 283	26 047 478	23 511 892	23 628 049	24 081 272	22 839 173	23 575 713	21 830 611	24 349 595	16 969 483	16 477 384			
22	Emissions		51 748 127	48 112 433	44 269 872	42 298 865	42 150 540	36 231 998	29 358 342	28 432 283	26 047 478	23 511 892	23 628 049	24 081 272	22 839 173	23 575 713	21 830 611	24 349 595	16 969 483	16 477 384			
23	N bedding (wav. 1.27 kg N per animal per yr.)	kg N/yr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Počítá se ve FCR		
24	N bedding (wav. 0.3 kg N per animal per yr.)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
25	CH4	Gg	21.24	19.77	18.25	18.02	17.75	15.20	12.41	12.04	10.98	9.92	9.97	10.16	9.79	2.91	2.65	2.75	2.50	2.43	Výpočet na samostatném sh		
26	Method		T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1			
27	EF Used		D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D			
28	Implied emission factor	CRF	6.32	6.32	6.34	6.35	6.27	6.25	6.30	6.30	6.28	6.29	6.28	6.28	6.28	6.26	6.27	6.26					
29	CH4	kg/head/y	6.32	6.32	6.34	6.35	6.27	6.25	6.30	6.30	6.28	6.29	6.28	6.28	6.28	1.81	1.78	1.77	1.620	1.623			
30	Additional information		6.32	6.32	6.34	6.35	6.27	6.25	6.30	6.30	6.28	6.29	6.28	6.28	6.28	1.81	1.78	1.77	1.62	1.62			
31	Allocation by climate region																						
32	**Anaerobic lagoon**																						
33	Cool	%	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	41.6	42.5	42.1	44.8	44.8			

3 B1 Methane emissions from manure management, other livestock (Tier 1)

Emissions CH_4 (eq. 10.12): population * EF_p

Emission factors from Table 10.15, developed countries

Sheep: 0.19
Goats : 0.13
Horses: 1.56
Poultry: 0.173 (weighted average, considered 13% wet and 87% dry manure)

Animal population from Czech Statistical Yearbook

Calculated directly in „central“ excel tool

Animal Waste Management System from expert opinion to statistical survey

	Type of AWMS				
	Fraction of Manure Nitrogen per AWMS [%]				
	Anaerobic digesters	Liquid	Daily spread	Solid	PRP
Dairy cows					
1990	0	25	2	68	5
1995	0	23	1	66	10
2000	0	15	1	74	10
2005	0	26	1	62	11
2010 – 2015	0	27	1	65	7
2016	32	11	0	57	0
2017	32	11	0	57	0
2018	32	11	0	57	0
2019	32	11	0	57	0
Non Dairy cattle (Weighted AVG)					
1990	0	45	1	42	12
1995	0	43	1	39	17
2000	0	44	1	38	17
2005	0	49	1	34	16
2010	0	43	1	32	24
2011 – 2015	0	42	1	32	25
2016	3	7	0	63	27
2017	3	7	0	63	27
2018	3	7	0	63	27
2019	3	7	0	62	28

Comparison of Nitrogen excretion data used in NIR, Submission 2020 and Submission 2021

	Annual N excretion rates	
Animal category	Nex, Submission 2020 kg N/head/year	Nex, Submission 2021 kg N/head/year
Dairy cattle	142.86	109.20
Other cattle	70.18	58.71
Swine	15.60	11.79
Sheep	15.50	9.00
Goats	23.40	9.00
Horses	58.50	49.31
Poultry	0.49	0.51

Nitrogen production in manure distributed by individual AWMS (kg N/yr), submission 2017, 2020 and 2021

AWMS	Nitrogen Production in Manure [kg N/yr], Submission 2017	Nitrogen Production in Manure [kg N/yr], Submission 2020	Nitrogen Production in Manure [kg N/yr], Submission 2021
Anaerobic digesters	0	29 778 518	22 419 820
Liquid systems	61 156 806	18 649 564	15 281 861
Daily spread	1 188 354	0	0
Solid storage	62 693 085	96 132 874	78 318 201
Pasture, range and padd.	23 552 536	23 496 288	19 529 172
Other	9 632 774	0	0
Total	158 223 555	168 056 745	135 549 054

3B2 Direct N2O emission from manure (Tier 2 for all animals)

N_2O production - by nitrification-denitrification processes occurring in the manure nitrogen (effect of climate conditions)

Estimated in the „central spreadsheet“.

Activity and input data, close cooperatrion with Crop Research Institute:

- Animal populations,
- Since 2019, Nitrogen excretion rate (kg N/animal/year) – CS number, from Decree 377/2013 Coll., annual update, shared between reporting
- AWMS, CS, annual update, based on statistical survey, shared between reporting
- Default emission factor EF_3 from table 10.21 (kg N2O-N per kg N excreted):
  liquid 0,005, solid storage 0,02, anaerobic digesters 0

3B2 Indirect N2O emission from manure (Tier 1)

Eq. 10.26, 10.27, 10.28

- N lost due volatilization = Amount of nitrogen excreted per AWMS fractions * percent of managed manure nitrogen for livestock category volatilizes as N gas ($FRAC_{GasMS}$).

  Default values from table 10.22

- N lost due to leaching – CS number, derived from research report, 1% from solid manure storages

3D Direct N2O emissions from soils (Tier 1, Eq.11.1)

Formed by microbial nitrification and processes in soils

Ca. 40 % of total agricultural emissions as direct emission from soil.

Activity data (Statistical Yearbook):

- Amount of nitrogen applied as industrial nitrogen fertilizers (MoA)
- Managed manure nitrogen available for soil - Eq. 10.34 (calculated)
- Annual amount of other organic fertilizers applied to soils - sewage sludge (CzO) and digestate (expert opinion)
- Annual amount of urine and dung N deposited by grazing animals on PRP (Eq 11.5)
- Annual amount of N from crop resudues and N-fixing crops (harvest/production area) Eq. 11.7. 11.7A
- Amount of N in mineral soils that is mineralized (FSOM), change of LU or management Eq.11.8
- Default emission factors (T. 11.1): EF_1 (=0.01) and EF_3 (= 0.02, 0.01)

Portions of nitrogene and N2O direct emissions from agricultural soils, submission 2019

Fraction	Kg N/year	N_2O Gg	Share of total, %
F_{SN}	332 032 000	5.218	55 %
F_{SEW}	3 354 531	0.053	1 %
F_{AM}	55 678 534	0.875	9 %
$F_{OON\ (digestate)}$	21 421 000	0.337	4 %
F_{PRP}	19 529 172	0.582	3 %
F_{CR}	172 043 326	2.704	28 %
F_{SOM}	1 599 340	0.025	0 %
Total direct emission	605 657 903	**9.793**	**100 %**

3D Indirect emissions from soils (Tier 1)

Volatilization - N2O from atm. deposition of N volatilized from managed soils (Eq. 11.9, T. 11.3):

Input data:

- $F_{SN} * Frac_{GASF}$
- $(F_{ON} + F_{PRP}) * Frac_{GASM}$
- Emission factor $EF_4 = 0.01$

($Frac_{GASF} = 0.10$, $Frac_{GASM} = 0.20$)

3D Indirect emissions from soils (Tier 1)

N2O emissions from **leaching and runoff** in regions where leaching and runoff occurs (Eq. 11.10, T. 11.3):

Input data:

- $(F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) * Frac_{LEACH-H}$
- Emission factor $EF_5 = 0.0075$

($Frac_{LEACH-H} = 0.30$)

3G CO_2 emissions from liming (Tier 1)

Eq. 11.12

Activity data:

- Annual amount of limestone applied to cropland and grassland.
- Annual amount of dolomite applied to forest land and cropland/grassland

Data source: MoA

3H CO_2 emissions from urea fertilization (Tier 1)

Eq. 11.13

Activity data:

- Annual amount of N in urea fertilizers, t/year, information source Ministry of Agriculture
- Annual amount of N in DAM (fertilizer containing urea)

From annual amount of N is calculated total consumption of urea products per year

Quality assumtion/Qaulity control CPlan

- IFER colleageus provide internal routine technical support (data, spreadsheets, reports)
- The consistency of AD is crosschecked with information from other sources (Czech Statistical yearbook versus documents and data from Ministry of Agriculture)
- Input data are consulted and shared with experts from agricultural research institute, universities and other subjects
- Update of calculation spreadsheets in cooperation with data specialist (technical point of view)
- Close cooperation with officials from MoA and MoE regarding specific issues (projections), assumption of emission reduction, missing data

Personal recommendation – not only one sectoral expert!!!


Thank you!