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Part 1 - Manure management

Manure management and link to anaerobic digestion (biogas) in 5B2

Updating emission factors

- Methodology + parameters/emission factors
- Changing methodology
  - Scientific review and technical writing
  - Users of Tier 2 methodology need to revise their inventory systems
  - Requires substantial resources
- Changing emission factors
  - Scientific review and technical writing
- Ammonia emission factors for 3B not updated in many years.

Ammonia emission factors – housing & storage (3B)

- Review of scientific literature
- Livestock housing
  - Cattle (solid and liquid manure, dairy and others)
  - Pig (solid and liquid manure, finishers and others)
  - Poultry (solid and liquid manure, broilers and layers)
- Manure storage
  - Solid and liquid
  - Cattle, pig and poultry
- Results
  - Many results for some sources, few or none

Ammonia emission factors – housing & storage

- Emissions should increase with increasing temperature
- Too few measurements
  - Median emission per type
- Many small changes, a few large ones

Code	Livestock	Manure type	$EF_{housing}$	New	$EF_{storage}$	New
3B1a	Dairy cattle	Slurry	0.20	0.24	0.20	0.25
		Solid	0.19	0.08	0.27	0.28
3B1a	Dairy cattle, tied housing	Slurry	0.066	0.09	0.20	0.25
		Solid	0.066	0.09	0.27	0.28
3B1b	Non-dairy cattle (young cattle, beef cattle and suckling cows)	Slurry	0.20	0.24	0.20	0.25
		Solid	0.19	0.08	0.27	0.28
3B2	Sheep	Solid	0.22	0.22	0.28	0.28
3B33	'Swine' (fattening pigs, 8–110 kg)	Slurry	0.28	0.27	0.14	0.11
		Solid	0.27	0.23	0.45	0.63
3B3	'Swine' (sows and piglets to 8 kg)	Slurry	0.22	0.35	0.14	0.11
		Solid	0.25	0.24	0.45	0.63
		Outdoor	NA	NA	NA	NA
3B4a	Buffalo[c]	Solid	0.20	0.20	0.17	0.17
3B4d	Goats)	Solid	0.22	0.22	0.28	0.28
3B4e+ 3B4f	Horses (and mules, asses)	Solid	0.22	0.22	0.35	0.35
3B4gi	Laying hens (laying hens and parents)	Solid, can be stacked	0.41	0.20	0.14	0.05
3B4gi	Laying hens (laying hens and parents)	Slurry, can be pumped	0.41	0.41	0.14	0.14
3B4gii	Broilers (broilers and parents)	Solid	0.28	0.21	0.17	0.27
3B4giii	Turkeys	Solid	0.35	0.35	0.24	0.24
3B4giv	Other poultry (ducks)	Solid	0.24	0.24	0.24	0.24
3B4giv	Other poultry (geese)	Solid	0.57	0.57	0.16	0.16
3B4h	Other animals (fur animals)	Solid	0.27	0.27	0.09	0.09

Ammonia emission factors – liquid manure applied to soil (3D)

- Emissions should depend on weather and the physical and chemical characteristics of the manure and soil
- Revised ALFAM model (ALFAM2)
  - Based on many measurements
- Model takes account of
  - Temperature, windspeed and rainfall
  - Dry matter content and application rate
- Advantage
  - Better account for local conditions (-- Tier 3)
- Disadvantage
  - Need reasonable estimates for local conditions

Conditions assumed for manure and fertiliser applications

- We lack data
  - Few countries collect data
  - Need to make assumptions
- Assumptions – detailed in background documents
  - Good agricultural practice
  - Arable crops – mainly applied in spring, some in autumn
  - Grassland – throughout growing season but mainly in spring

Table 2 Seasonal distribution of manure applications by type

Manure type	Spring	Summer	Autumn	Winter
Liquid	33	20	20	28
Solid	28	20	25	28

Conditions assumed for manure and fertiliser applications

- Meteorological data
  - Climate maps
  - Expert judgement

Table 3 Air temperatures used for the seasonal application of slurry and N fertiliser

Region	Spring	Summer	Autumn	Winter
	Celsius			
Cool	7	15	12	4
Temperate	7	18	15	4
Warm	15	25	20	6

- Manure dry matter and application rate
  - Average values from ALFAM2 database

Ammonia emission factors – solid manure applied to soil (3D)

- Emissions should depend on weather and the physical and chemical characteristics of the manure and soil
  - Too few measurements to establish relationships
- Median values used
  - Some substantial changes (reductions)
  - Note minor corrections

Code	Livestock	Manure type	$EF_{spreading}$	New	$EF_{grazing/outdoor}$	New
3B1a	Dairy cattle	Slurry	0.55	0.25	0.10	0.09*
		Solid	0.79	0.65	0.10	0.09*
3B1a	Dairy cattle, tied housing	Slurry	0.55	0.25	0.10	0.09*
		Solid	0.79	0.68	0.10	0.09*
3B1b	Non-dairy cattle (young cattle, beef cattle and suckling cows)	Slurry	0.55	0.25	0.06	0.09*
		Solid	0.79	0.68	0.06	0.09*
3B2	Sheep	Solid	0.90	0.90	0.09	0.05*
3B33	'Swine' (fattening pigs, 8–110 kg)	Slurry	0.40	0.19		
		Solid	0.81	0.45		
3B3	'Swine' (sows and piglets to 8 kg)	Slurry	0.29	0.19		
		Solid	0.81	0.45		
		Outdoor	NA	NA	0.25 (c)	0.19* (e)
3B4a	Buffalo[c]	Solid	0.55	0.55	0.13	0.13
3B4d	Goats)	Solid	0.90	0.90	0.09	0.09
3B4e+ 3B4f	Horses (and mules, asses)	Solid	0.90 (d)	0.90 (e)	0.35	0.35
3B4gi	Laying hens (laying hens and parents)	Solid, can be stacked	0.69	0.45		
3B4gi	Laying hens (laying hens and parents)	Slurry, can be pumped	0.69	0.69		
3B4gii	Broilers (broilers and parents)	Solid	0.66	0.38		
3B4giii	Turkeys	Solid	0.54	0.54		
3B4giv	Other poultry (ducks)	Solid	0.54	0.54		
3B4giv	Other poultry (geese)	Solid	0.45	0.45		
3B4h	Other animals (fur animals)	Solid	NA	NA		

Ammonia emission factors – manure management

- Emissions should depend on weather and the physical and chemical characteristics of the manure (and soil)
  - Currently cannot do this except for liquid manure applied to soil
- Update leading to better documentation
  - Appendices
  - Peer-reviewed paper
- Recommend adoption

Linking manure management (3B), soils (3D) & anaerobic digestion (5B2)

- 3B uses a nitrogen flow approach
  - Nitrogen input by animals is followed until it enters the soil
  - Accounts for knock-on effects
- Nitrogen “moves” between chapters
  - Manure nitrogen that is anaerobically digested is ‘sent’ to 5B2
  - Digestate is ‘sent’ from 5B2 to 3B (or 3D)
- Modify equations in 3B and 5B2 to maintain nitrogen flow approach in 3B
  - Also need to calculate ammoniacal and total nitrogen flows

Ammonia emission factors – manure management

- Recommend that updated chapters 3B, 3D and 5B2 be adopted