GHG Emission from Livestock waste management

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Animal number and amount of manure in Japan

Table 1

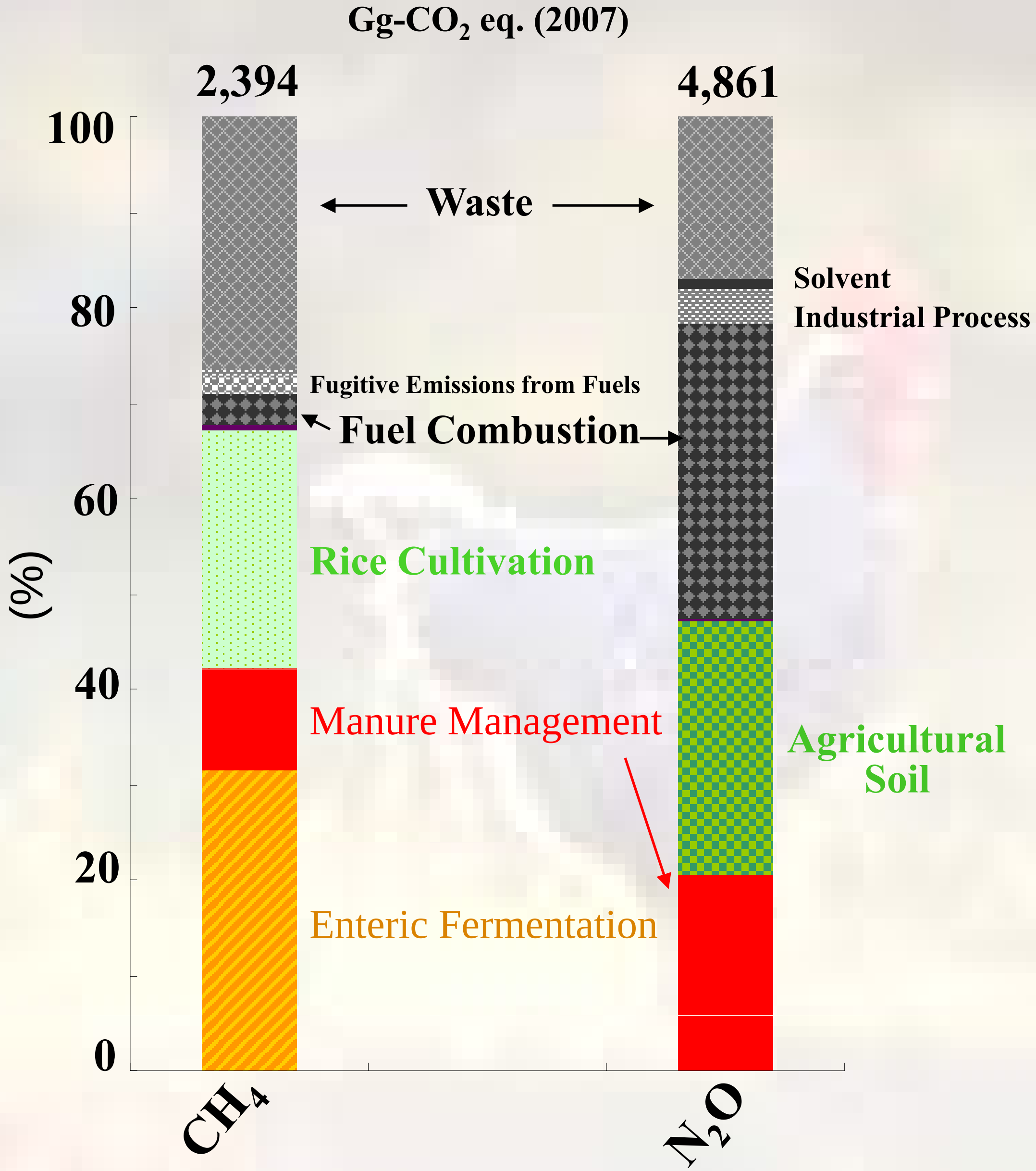
	Livestock herd (1,000 head)	Manure (t/yr)			
		Feces	Urine	O.M.	N
Daily Cattle	1,533	21,206	6,261	3,424	134.9
Non-daily Cattle	2,890	18,990	6,872	3,452	130.9
Swine	9,745	7,857	14,586	1,644	151.5
Hen	181,664	7,698		1,154	154.0
Broiler	104,950	4,975		746	99.5
total		60,725	27,719	10,421	670.8

88 million t of manure

Excreted as manure

10.4 million t of O.M.
0.67 million t of N
/ yr

CH_4 and N_2O emission from Agriculture



67.1% of CH_4 and 47.1% of N_2O are emitted from agriculture sector.

Estimation Method

CH_4

$$E = \sum (EF_n \times A_n)$$

E: Methane emission (g-CH_4)

EF*n*: Emission factor for treatment method *n* (g-CH_4/g-OM)

A*n*: Amount of OM contained in manure treated by method *n* (g-OM)

N_2O

$$E = \sum (EF_n \times A_n) \times 44/28$$

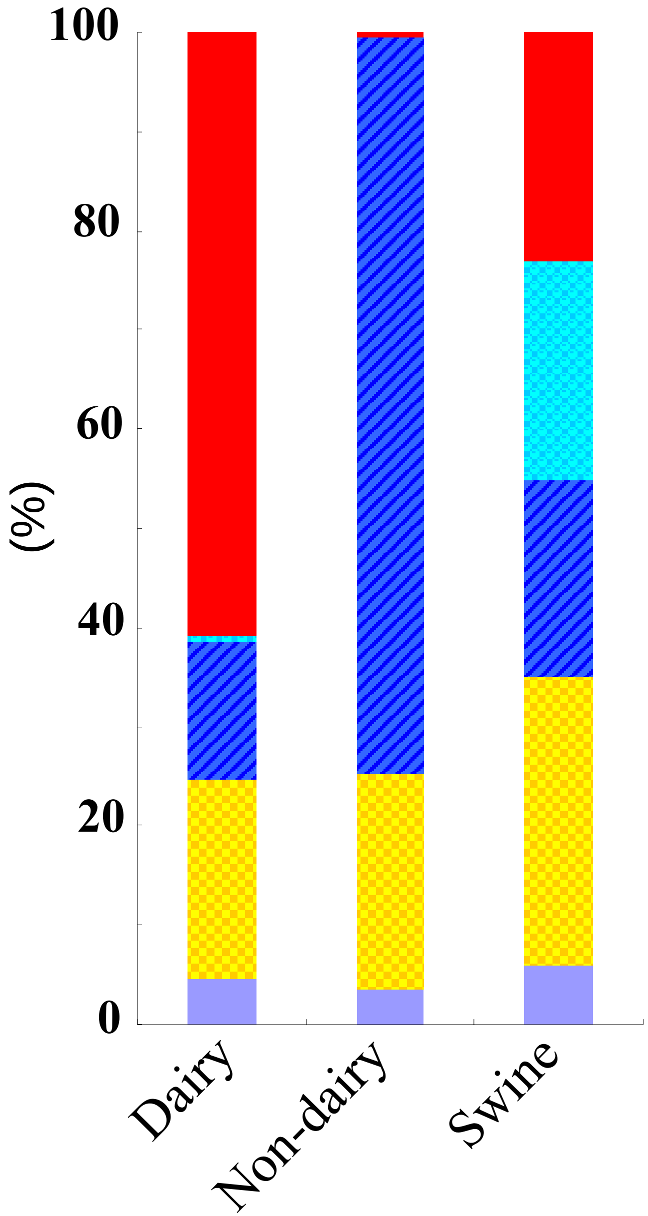
E: Nitrous oxide emission (g-N_2O)

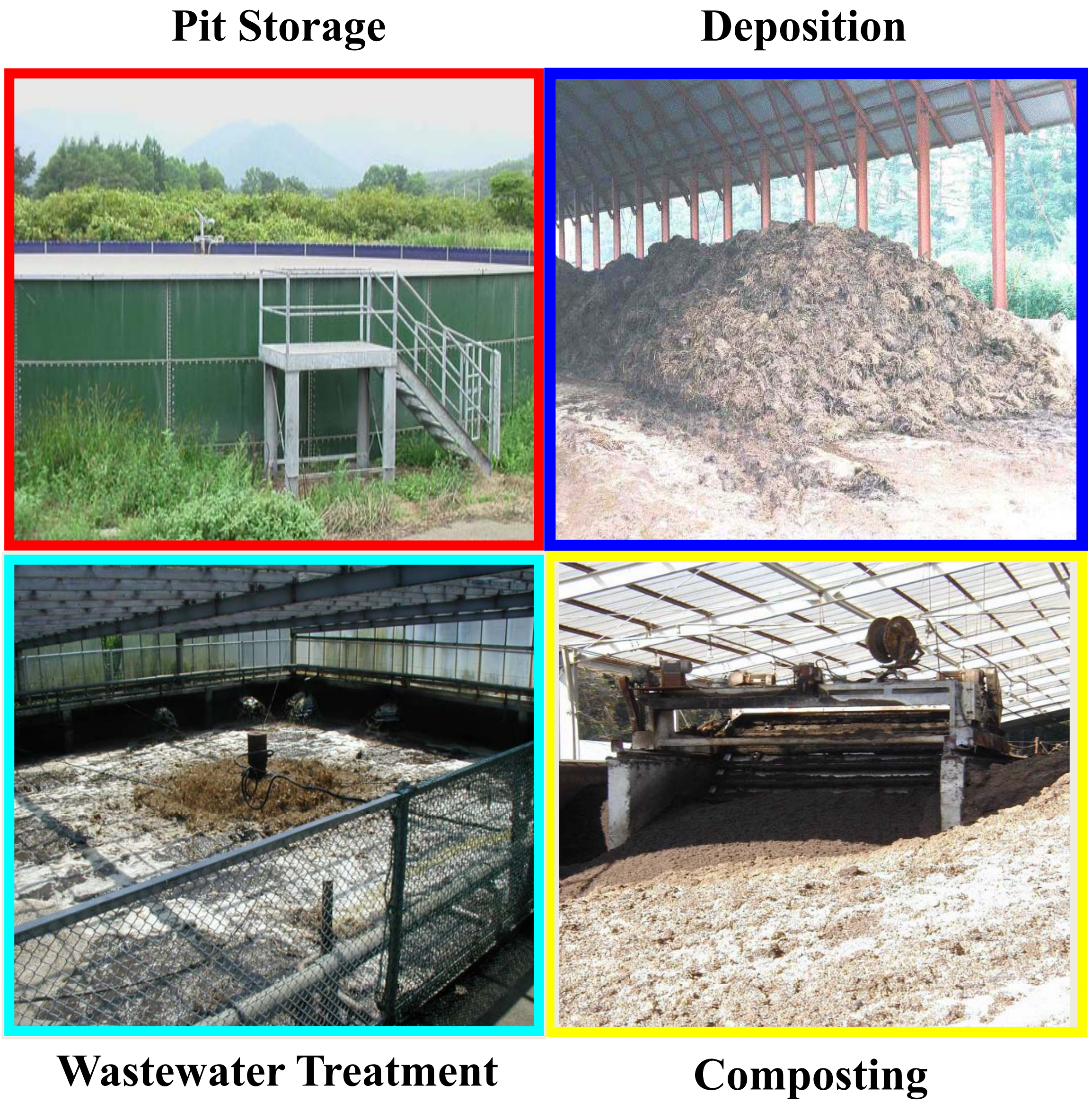
EF*n*: Emission factor for treatment method *n* (g-N_2O/g-N)

A*n*: Amount of N contained in manure treated by method *n* (g-N)

Type of Manure Management

Mixed feces and urine

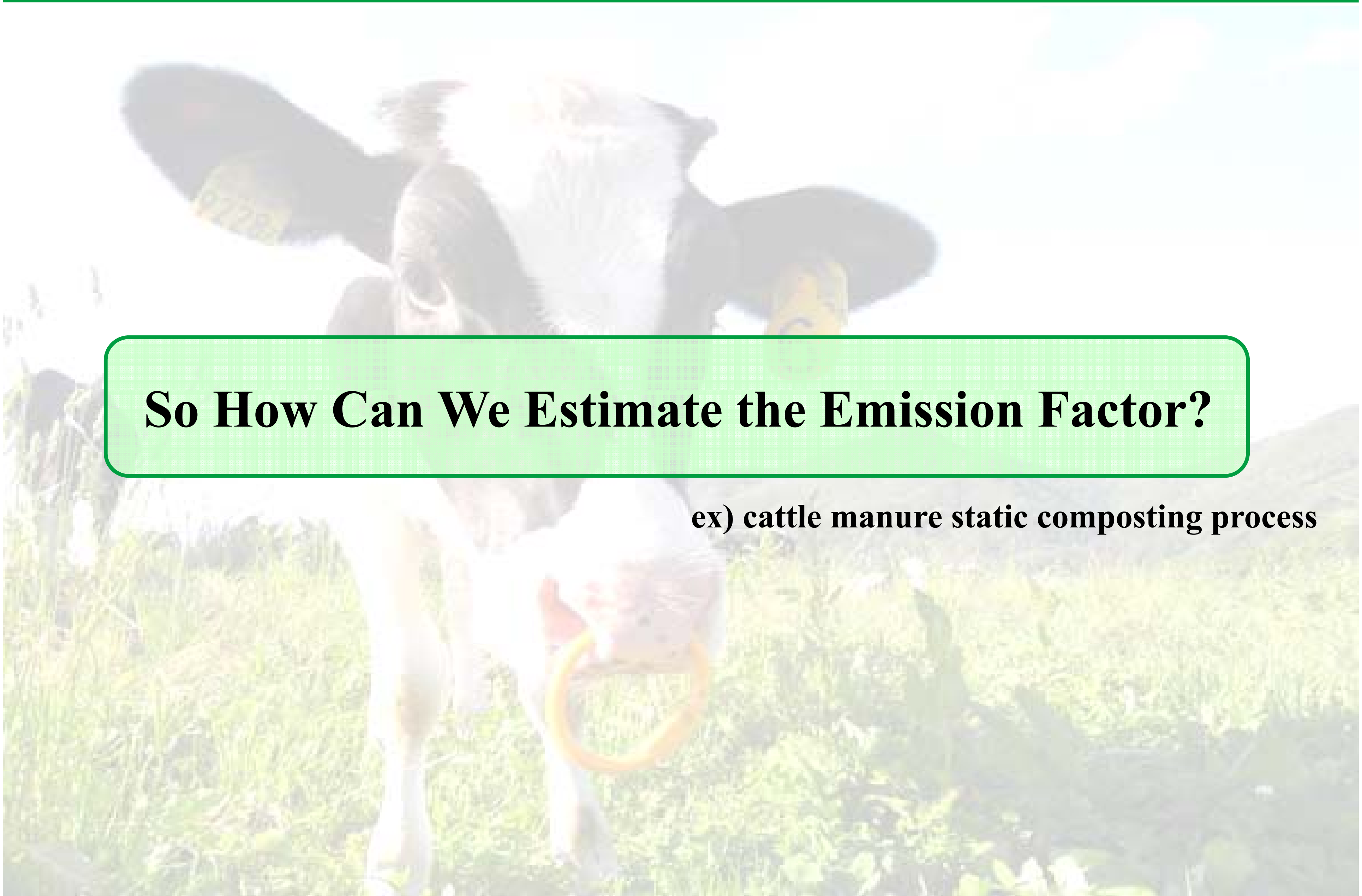




Emission Factor

		Dairy Cattle	Non-dairy Cattle	Swine	Hen Broiler	(%)
CH_4	Pit Storage	**3.9**	**3.0**	**8.7**		
	Sunlight Drying	0.2	0.2	0.2	0.2	
	Composting (feces)	**0.044**	**0.034**	**0.097**	**0.14**	
	Composting (feces and urine mixed)	**3.8**	**0.13**	**0.16**	**0.14**	
	Deposition	0.4	0.4	0.4	0.4	
	Incineration	0.044	0.034	0.097		
	Wastewater management	**0.0087**	**0.0067**	**0.019**		
N_2O	Pit Storage	**0.1**				
	Sunlight Drying	2.0				
	Composting (feces)	**0.25**				
	Composting (feces and urine mixed)	**2.4**	**1.6**	**2.5**	**2.0**	
	Deposition	0.1				
	Incineration	2.0				
	Wastewater management	**5.0**				

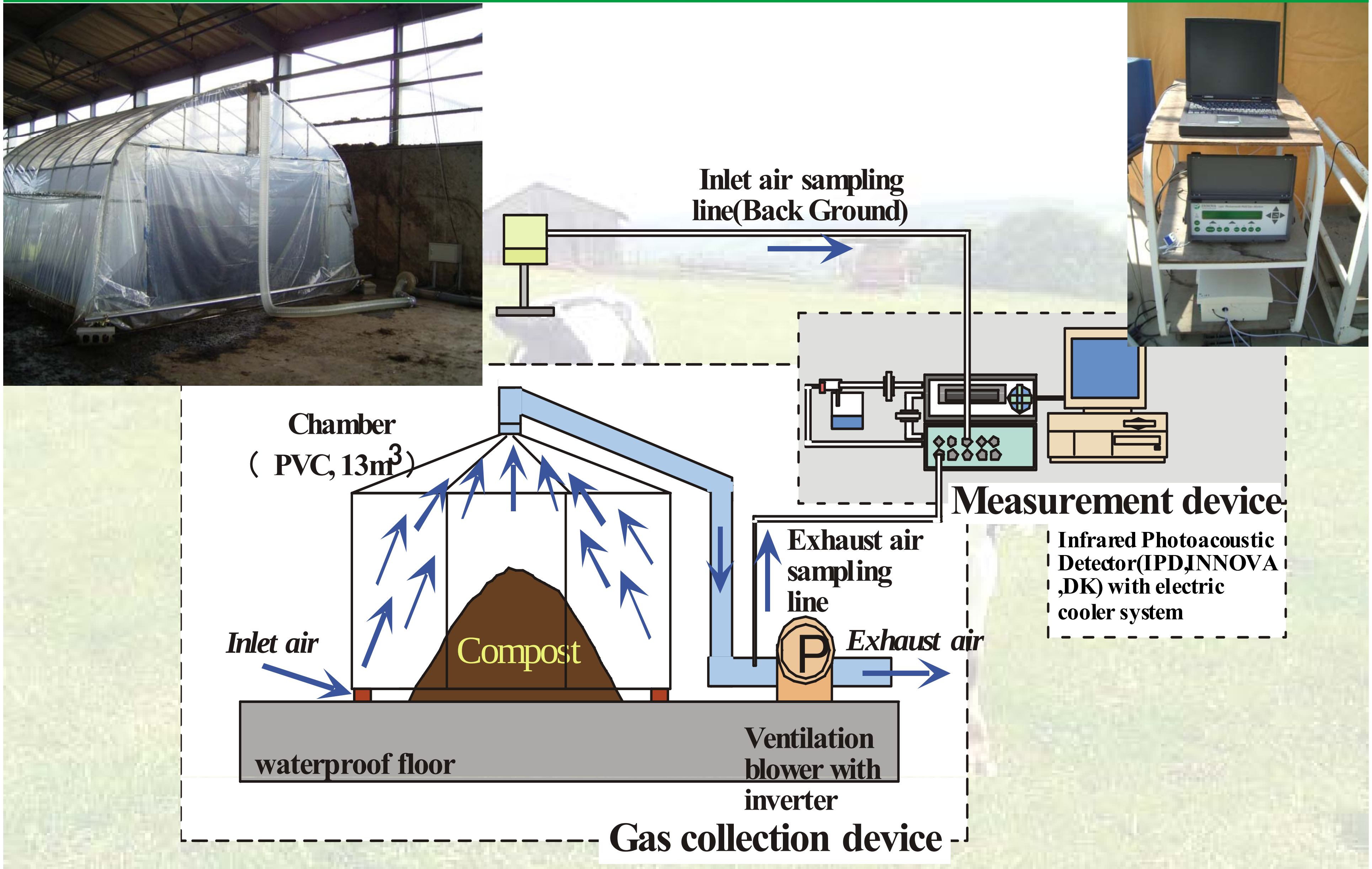
Established by data of Japan
Default value of IPCC Guideline



So How Can We Estimate the Emission Factor?

ex) cattle manure static composting process

Measurement of GHG emission from cattle manure composting process

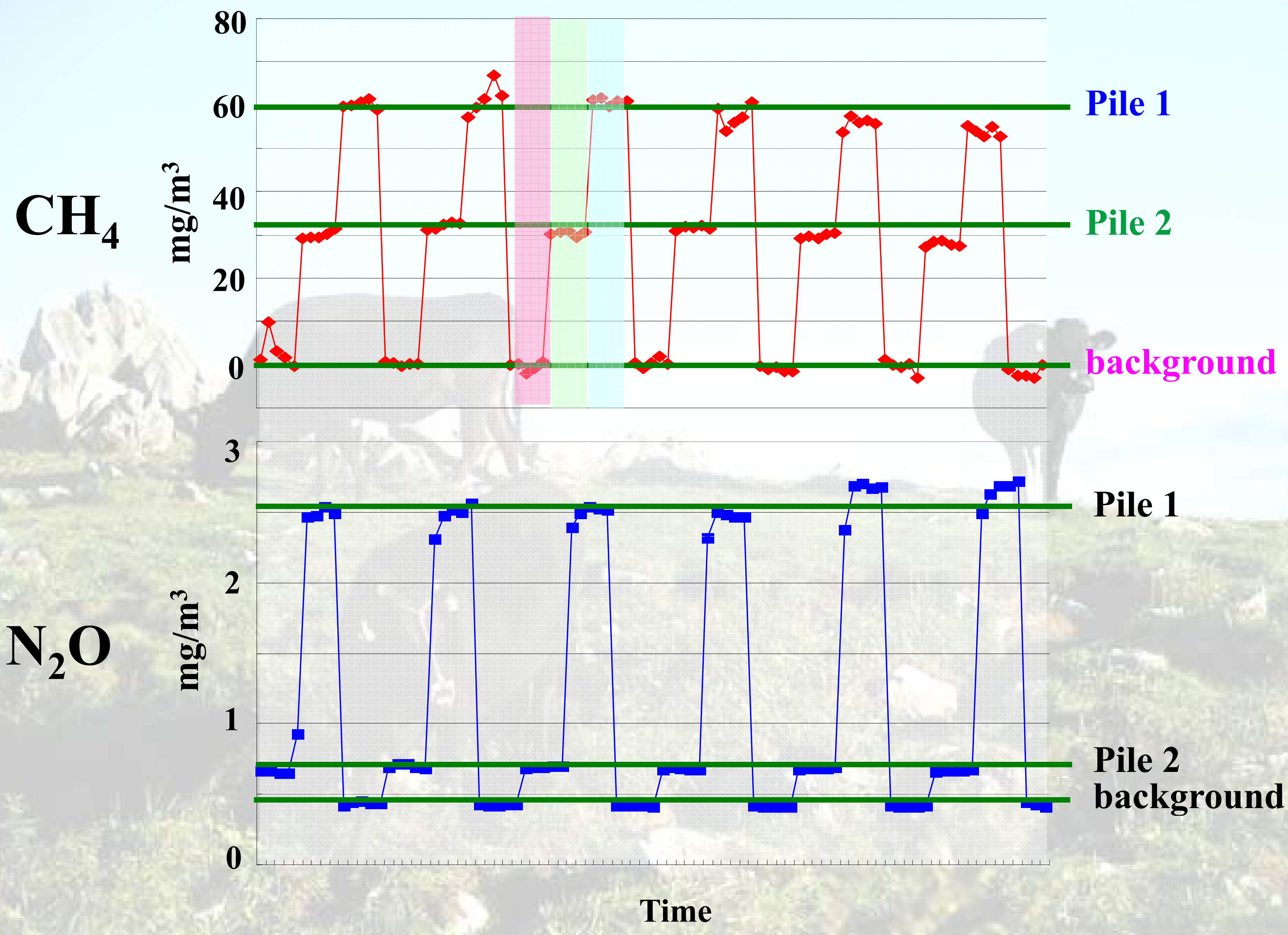


Maeda et al., Journal of Environmental Quality 38:598-606 (2009)

Raw data 1 (gas conc.)

	Time	NH_3	N_2O	CO_2	CH_4 (ppm)
Pile 1	2007/5/21 11:11	13.6	1.54	1918.3	12.4
	2007/5/21 11:13	16.4	1.53	1912.6	12.8
	2007/5/21 11:15	17.2	1.54	1922.5	11.5
	2007/5/21 11:17	17.4	1.55	1924.3	12.1
Change port	2007/5/21 11:19	17.3	1.54	1896.1	12.1
Pile 2	2007/5/21 11:21	19.9	1.92	1725.2	27.8
	2007/5/21 11:23	23.2	1.95	1779.7	28.2
	2007/5/21 11:25	24.9	1.95	1783.4	28.5
	2007/5/21 11:27	25.7	1.95	1762.5	27.4
Change port	2007/5/21 11:29	26.1	1.96	1776.1	27.7
background	2007/5/21 11:31	0.8	0.45	406.4	2.6
	2007/5/21 11:33	5.1	0.44	395.8	2.4
	2007/5/21 11:35	2.4	0.44	393.5	3.2
	2007/5/21 11:37	1.3	0.45	393.7	3.0
	2007/5/21 11:39	0.8	0.45	400.2	2.3
	⋮	⋮	⋮	⋮	⋮

Raw data 2



CH4
mg/m3
80
60
40
20
0
Pile 1
Pile 2
background
N2O
mg/m3
3
2
1
0
Pile 1
Pile 2
background
Time

Calculation of GHG emission

農研機構 NARO

E (mg/30 min) =

(conc. of outlet air (mg/m^3) – conc. of inlet air (mg/m^3))

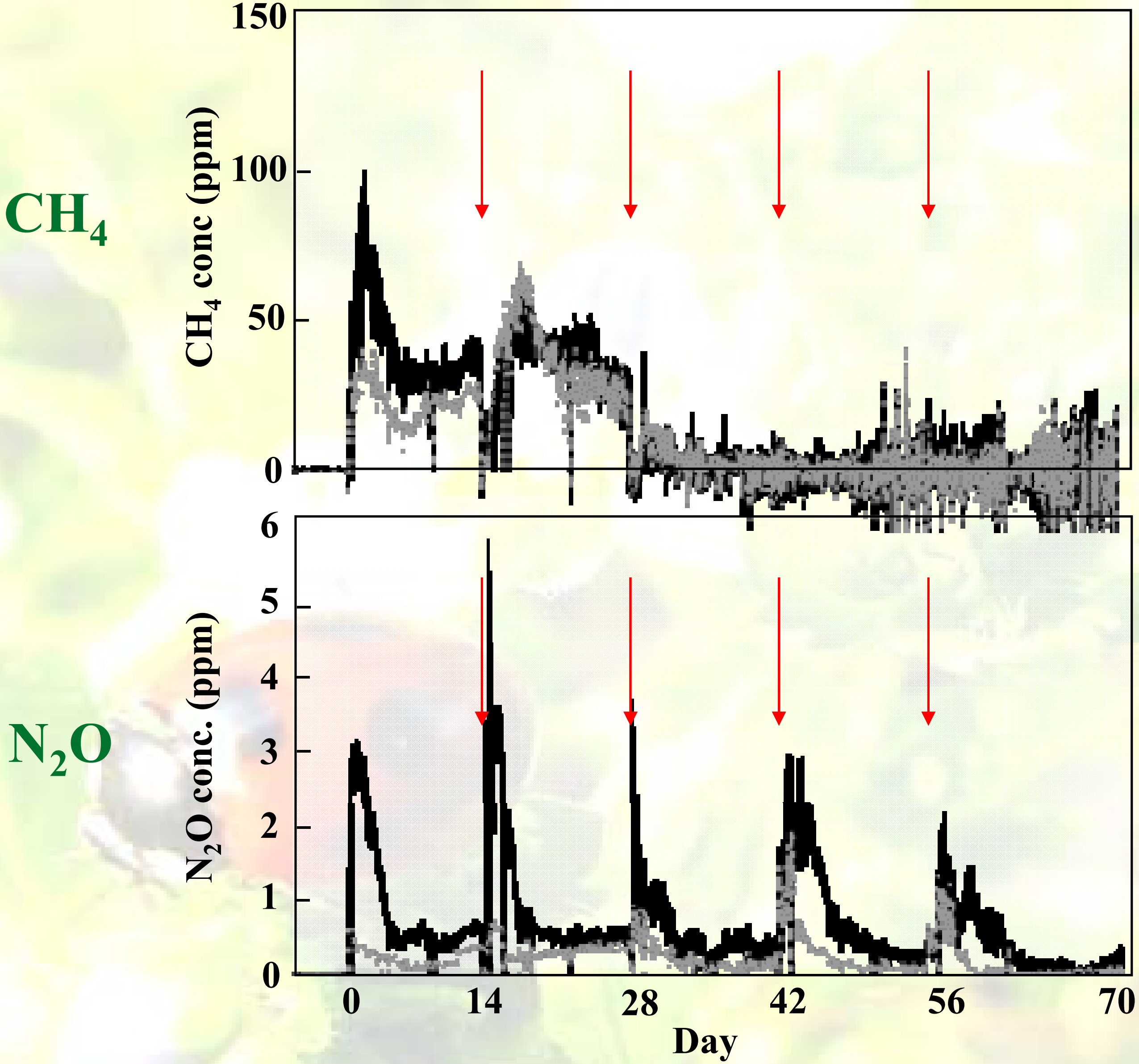
× 30(min)/60(min) × ventilation rate (m^3/h)

☆ Constant air flow which does not affect the microorganism revitalization

☆ Continuous, accurate measurement of GHG concentrations

☆ Sampling number as many as possible

GHG emission data



Maeda et al., Microbial Ecology, in press.

Mass balance

農研機構 NARO

Carbon

	(%/OM)
CH_4-C	0.24 - 0.46
CO_2-C	13.8 - 28.7
Mature Product	27.5 -36.7

Nitrogen

	(% initial N)
N_2O-N	1.2 - 1.3
NH_3-N	4.1 - 7.9
Mature Product	52.2 - 63.8

0.2-0.5% of initial OM was emitted as CH_4-C.

1.2-1.3% of initial N was emitted as N_2O-N.

Conclusion

農研機構 NARO

- 0.2-0.5% of initial OM was emitted as CH_4-C
- 1.2-1.3% of initial N was emitted as N_2O-N

during cattle manure composting process.

- Constant air flow which does not affect the microorganism revitalization
- Continuous, accurate measurement of GHG concentrations
- Sampling number as many as possible

Enables precise evaluation of actual GHG emission.

- N_2O was emitted just after the turnings with spike shapes.
- The stable isotope analysis indicate that N_2O was emitted mainly from the denitrification process. (Data not shown)
- The accumulated NO_2^--N and NO_3^--N in the surface indicates the reduction of these inorganic nitrogen seemed to be occurred after the mixing by the turnings.
- The abundance of *amoA* sequences were agreed with the accumulated NO_2^--N and NO_3^--N in the surface of the pile, which suggested that the *Nitrosomonas*-like AOB contribute the nitrification.

Thank you