Better evaluation system for N_2O and CH_4 emission from composting (and wastewater purification) of Livestock waste

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I would like to say

In this presentation

Why we focus on N_2O and CH_4 emission from Livestock waste treatment ?

Share , Agricultural sector, N cycle

How to evaluate ?
Measurement system and Experimental design

Evaluation and Mitigation of emission

Emission factor of N_2O and CH_4 from Livestock waste composting / in our experiment

Emission factor, changes in process

Why we focus on N_2O and CH_4 emission from Livestock waste treatment ?

-About 94 million tons of livestock waste

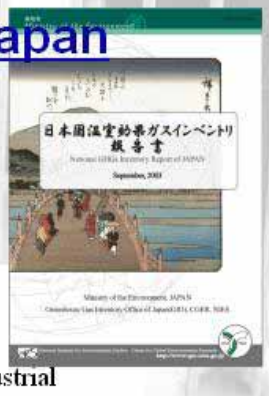
-contains 737 Gg of Nitrogen.

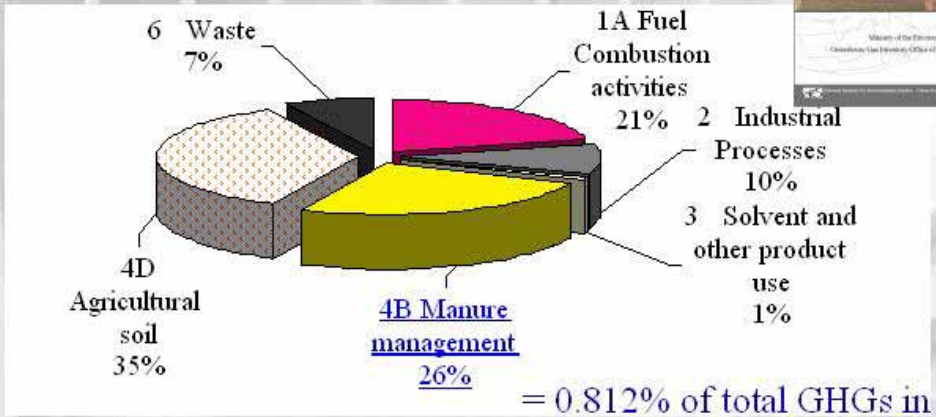
-around 10,999 Gg CO_2 eq of N_2O and 933 Gg CO_2 eq of CH_4 might be emitted from composting and other livestock waste treatment processes (Ministry of the Environment, Japan 2002).

II

Estimated source of N_2O in Japan

(anthropogenic generation , 2002)





= 0.812% of total GHGs in Japan
(one of key source category)

III

Treatment of livestock waste in Japan

(737.6Gg/y of N)

Livestock housing

Solid part

472~500 Gg

Composting

(Dry, Incineration ….)

Liquid part

24~91 Gg

Wastewater purification
(Activated sludge treatment)

How to evaluate ?
Measurement system and Experimental design

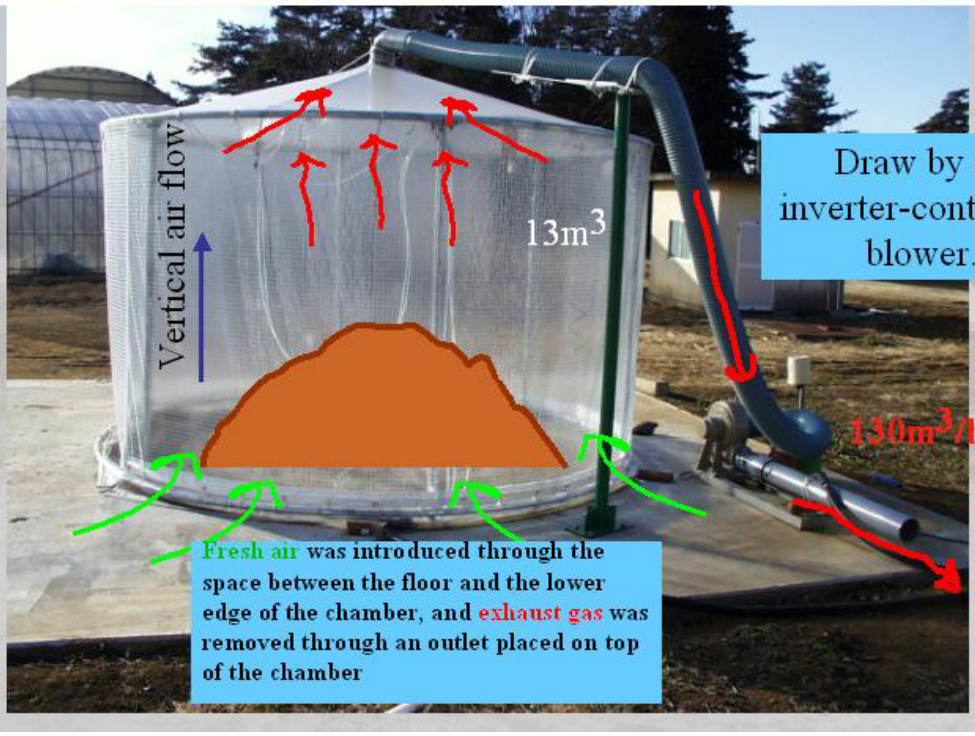
Measurement system

- -Gas collection and Measurement device
- -Calculation of emission
- -Is it correct ?

Variation of emission factor ?

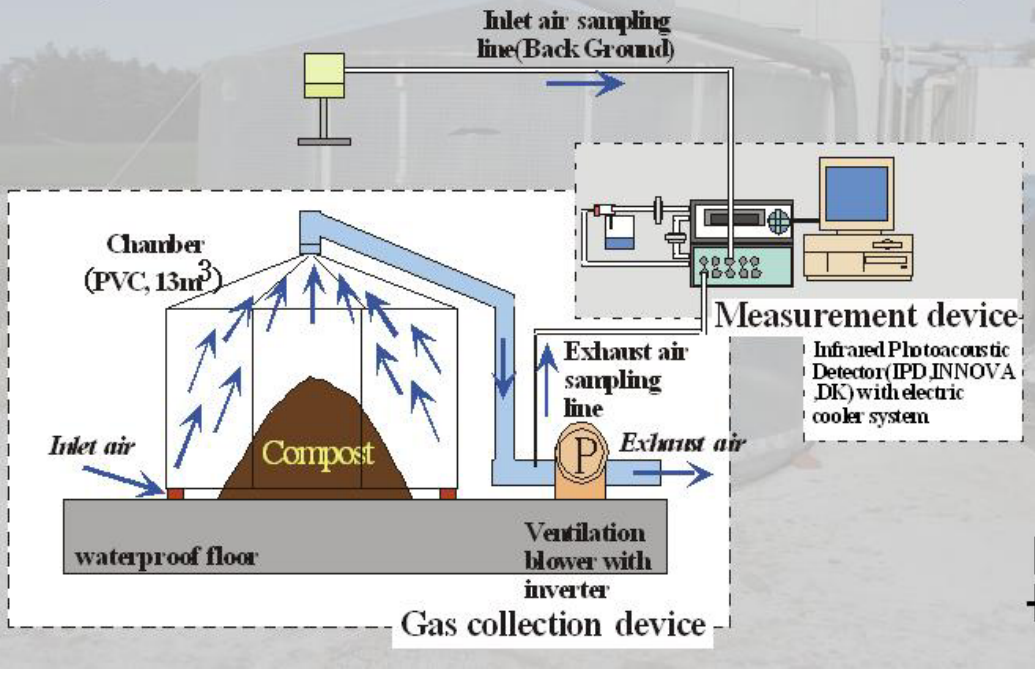
- - Livestock's
- - Moisture contents
- - Seasons

Measurement system (Gas collection device)



I

Measurement system
(Gas collection and Measurement device)

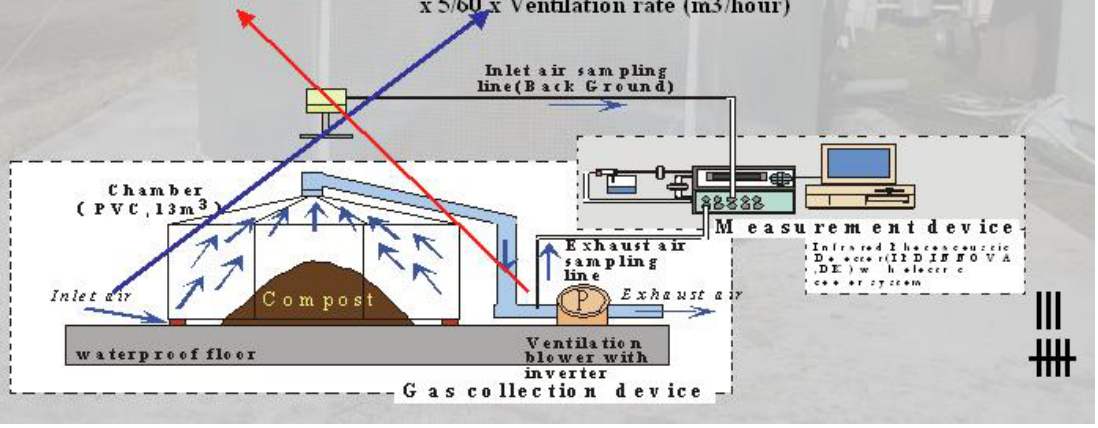


II

Measurement system
(Gas collection and Measurement device)

The rate of emission (E) of each substance (NH3, CH4 and N2O) was computed from the amount of ventilation and the concentration differences of each substance between the inlet and outlet air samples.

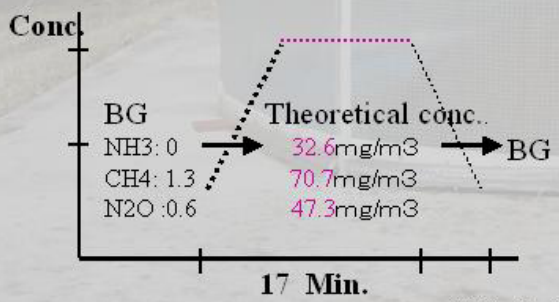
E (mg/5min.) =
(Conc. of outlet air (mg/m3) – Conc. of inlet air (mg/m3))
x 5/60 x Ventilation rate (m3/hour)

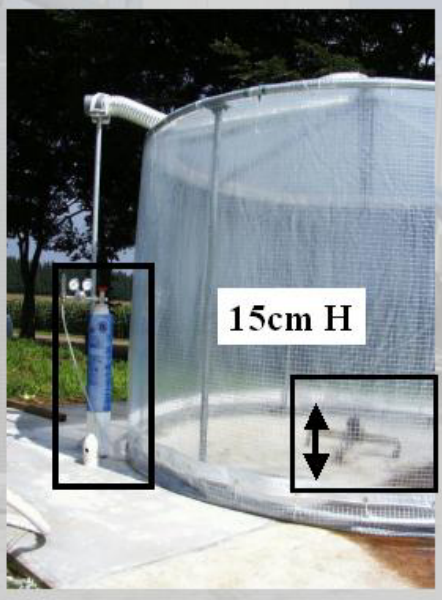


Methods for evaluation of this system

1st step
Recovery test with pure substances

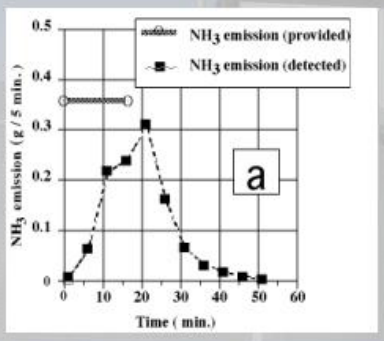
In order to evaluate recovery efficiencies, a fixed quantity of each substance (gas) was generated within the center of the chamber 15 cm high, and the total amount of emissions by this chamber system was calculated.





*Stabilized ventilation late and fixed late of gas generation

1st step
Result of Recovery test with pure substances

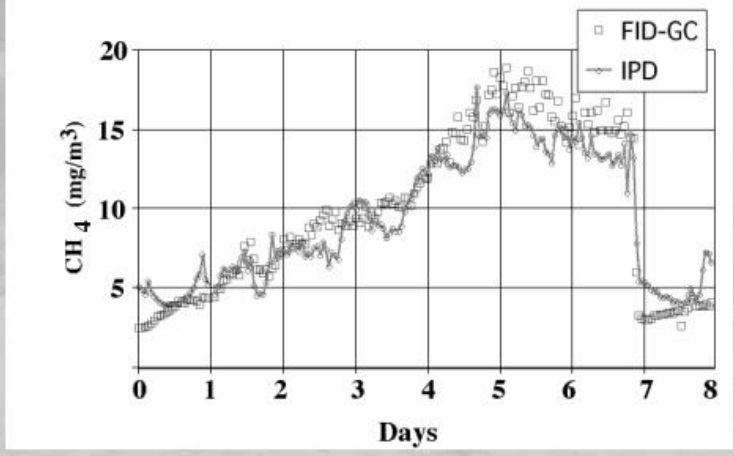


No great difference was found in movement of three sorts of substances. In the 130 m3/h exchange volume condition for 17-minutes the concentration of each substance became elevated during 40 - 50 minutes.

The average recovery of each substance was good based on the results of a field examination. NH3, CH4 and N2O recoveries were 98.5% (S.D. 6.25), 96.6% (S.D. 4.03) and 99.5% (S.D. 2.68), respectively

Step 2
Comparison with values from conventional methods at composting examination (CH4)

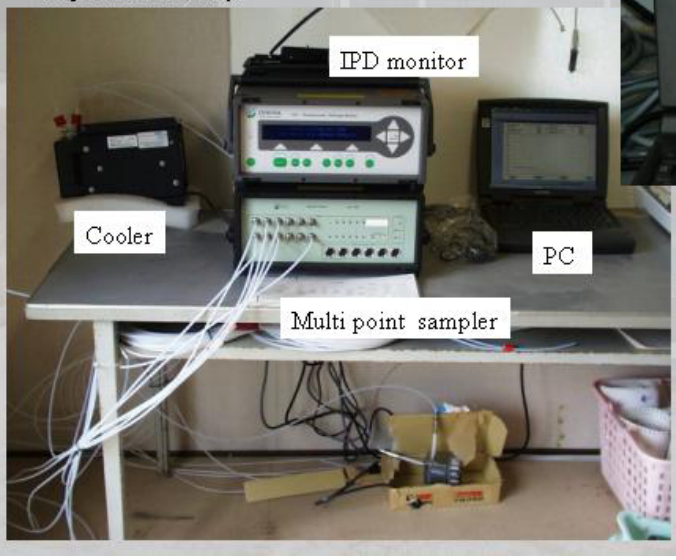
The results of both method were compared, and the changes of CH4 concentration were considered to be very similar.



The total amount of methane generated over 8 days following the start of the composting was 227g by the IPD method and 239g by the FID-GC method, and the difference was small at around 5%.

Measurement system (Measurement device)

-Infrared Photoacoustic Detector (IPD, multi gas monitor type 1312, INNOVA, Copenhagen DK) at 5-min. intervals(continuous measurement).
-Gas dried by electric cooler was used for measurement of methane and nitrous oxide for improved accuracy.



Sampling gas were introduced IPD passed through 4mm diameter Teflon tubes at 15min. Interval.

Experimental design

Mixture of Feces & Sawdust (400kg ap.)

Piled & Turned weekly →

Runs	Livestock	Products of the compostig		Turning interval of the pile	Days of composting
		Total weight	Moisture content		
		kg	%		
Dairy 1	Dairy cattle manure	602.0	83.5	15 days	119
Dairy 2		455.0	85.6	15 days	119
Beef 1	Beef cattle manure	149.4	45.7	7 days	63
Beef 2		198.0	56.1	7 days	49
Pig 1	Fattening pig manure	110.0	35.4	7 days	56
Pig 2		147.8	48.4	7 days	106
Pourtry 1	Poultry manure	112.0	11.9	7 days	64
Pourtry 2		99.2	25.9	7 days	57

N_2O and CH_4 emission from Livestock waste composting

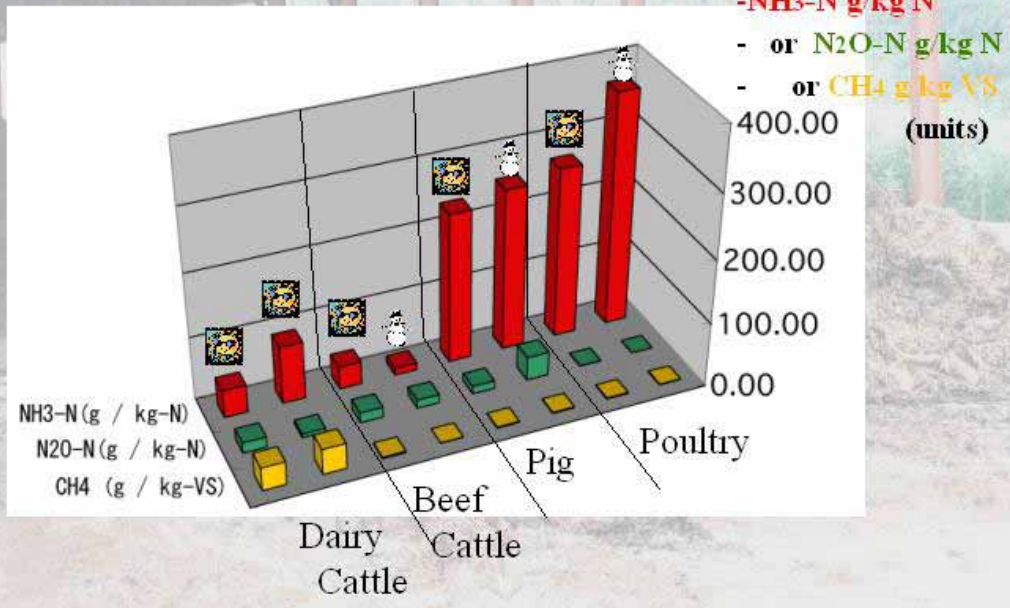
Gas emission factor

- N_2O-N g/kg N or CH_4 g/kg OM (units)
- Moisture content / Season
  / Dry (Am.Temp.)

Emission pattern

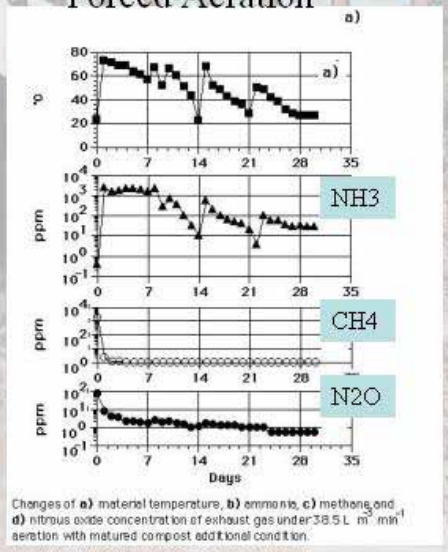
-Difference between Forced or Passive
-Ammonia and Nitrous Oxide

NH_3,N_2O and CH_4 emission during composting of each livestock manure



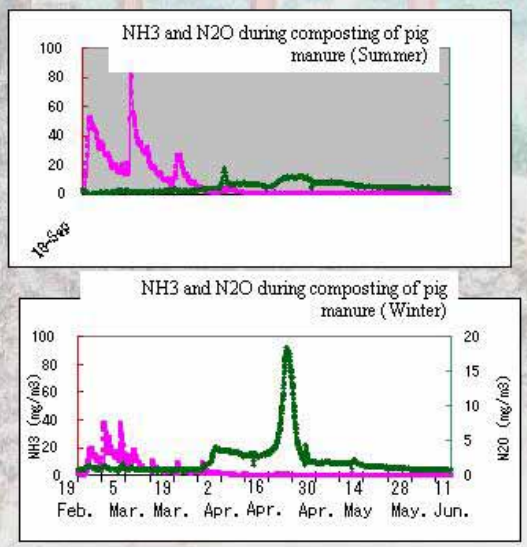
Changes of N_2O and NH_3 emission during composting

Gas emission from Forced Aeration



Changes of **a)** material temperature, **b)** ammonia, **c)** methane and **d)** nitrous oxide concentration of exhaust gas under 38.5 L m^{-3} min^{-1} aeration with matured compost additional condition.

Gas emission from Piled compost



Conclusion (1/2)

We developed a system for the quantitative measurement of emissions from composting using a large dynamic chamber in an experiment.

According to the results of this experiment, the composting-manure emission factors of CH_4 and N_2O varied significantly between livestock types, moisture contents of the pile materials and ambient temperature . Those factors should also depend on manure treatment type.

This can be important information not only for inventory data but for the development of greenhouse gas regulations and technologies.

Conclusion (2/2)

In Asian countries, the compost process is widely used for the treatment of livestock waste. Although the exact amount of greenhouse gases generated from actual composting is not known.

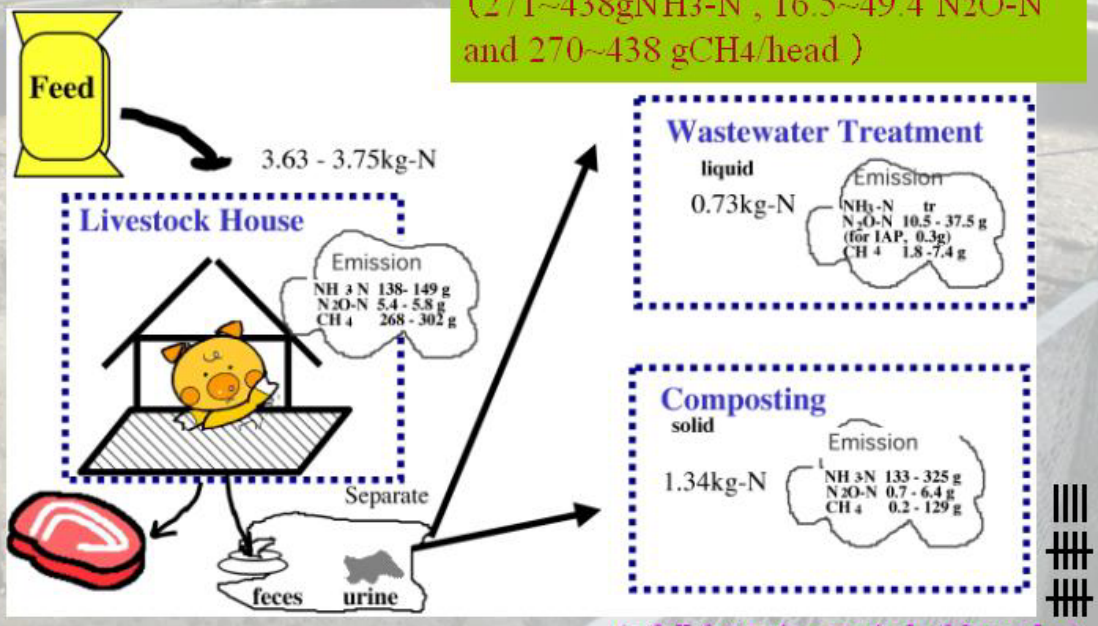
Not only the compost, but the emission factor of each treatment system should be evaluated under each countries procedure and general conditions, because those factors might be widely varied.

It is important that each country has the measurement technique of GHG emission, not only for inventory data but for the development of greenhouse gas regulations and technologies.

Emissions occure not only composting but also… … 1

The NH_3-N, N_2O-N and CH_4 emissions from the swine keeping unit and its manure contributes

(271~438gNH_3-N , 16.5~49.4 N_2O-N and 270~438 gCH_4/head)



(a full fattening period of 8 weeks)

Farther experiment near future

Barn and Poultry house

Wastewater treatment

Large Scale, Actual facilities

The greenhouse effect of Animal Industry origin might not be so big as you suppose, I hope.