Nitrous oxide, Methane and Ammonia mitigation trials in swine wastewater purification

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The aim of this presentation is ..

New wastewater treatment, carbon fiber reactor, possibly reduce GHG emission, especially N2O

• GHG from Livestock farming
  • The livestock sector plays an important role in climate change. and the **Manure-GHG** has mitigation potential.
  • Major manure management in Jp. (esp. wastewater)

• Field demonstration trials are currently going on in pig farm / (interim report)
Livestock: a significant contributor to climate change

With emissions estimated at 7.1 giga tones CO2-eq per annual, representing 14.5 percent of human-induced GHG emissions.

FAO. 2009.

FAO. 2006.

FAO. 2013.
Manure management contribute a major source of GHG

<table>
<thead>
<tr>
<th>STEP IN ANIMAL FOOD CHAIN</th>
<th>ESTIMATED EMISSIONS(^1)</th>
<th>ESTIMATED CONTRIBUTION BY SPECIES(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cattle and buffaloes</td>
<td>Pigs</td>
</tr>
<tr>
<td>Land use and land-use change</td>
<td>2.50</td>
<td>36</td>
</tr>
<tr>
<td>Feed production(^3)</td>
<td>0.40</td>
<td>7</td>
</tr>
<tr>
<td>Animal production(^4)</td>
<td>1.90</td>
<td>25</td>
</tr>
<tr>
<td>Manure management</td>
<td>2.20</td>
<td>31</td>
</tr>
<tr>
<td>Processing and transport</td>
<td>0.03</td>
<td>1</td>
</tr>
</tbody>
</table>

\(^1\) Estimated quantity of emissions expressed as CO\(_2\) equivalent.
\(^2\) ■ = lowest to ■■■■■ = highest.
\(^3\) Excludes changes in soil and plant carbon stocks.
\(^4\) Includes enteric methane, machinery and buildings.

Note: ns = not significant.
Source: Adapted from Steinfeld et al., 2006.

Main GHG source of Agri. above 4% of GHG share

This year’s report of The State of Food and Agriculture (FAO 2009)
Present manure management really managed manure?

Reduce the environmental impact for neighbor,
- Air quality (malodor, dust),
- Public water quality (N,P and pathogen pollution)…
- Reuse resources of manure as fertilizer

But not enough for GHG...new issue.
Treatment of livestock waste in Japan (GHG)

- Livestock housing
  - Edible parts
  - Inedible parts

- Composting
  - Solid part
    - 4860 Gg
  - Liquid part
    - 1540 Gg

- Pit storage & spread
  - 300 Gg

- Wastewater purification
  - 340 Gg

- Forced aeration (Mechanical turn)
  - Dry, Incineration...
Evaluation of GHG emission from Wastewater purification plants (Swine)

GHG emission from Livestock Wastewater purification facilities in JAPAN (%:EF)

0.91% (g CH$_4$ /g vs)
2.87% (g N$_2$O-N/g N)

Chiba 1

Chiba 2

Saga

Okayama 1

Okayama 2

National Agriculture and Food Research Organization
Okayama 1 wastewater treatment facility

Layout

- Pig barn
- Wastewater treatment facility
- Compost plant
- Office
Unit of CF reactor
Gas evaluation

During the aeration periods:
\[ E_a (mg/60 \text{ min.}) = (\text{Conc. of outlet air (mg/m}^3) - \text{Conc. of inlet air (mg/m}^3)) \times \text{Flow-rate (m}^3/\text{hour}) \]

Settled period (Sediment, not aeration):
\[ E_s (mg/60 \text{ min.}) = (\text{Conc. of outlet air (mg/m}^3) - \text{Conc. of inlet air (mg m}^3)) \times HS^* (m^3) \]

HS: Average capacity of head space of reactor tank (m³)
Reactions Inside the Treatment Tank

Activated sludge method (conventional method)

Carbon fiber method

In activated sludge

Activated sludge

Aeration tank

N\textsubscript{2}O

Carbon fiber

Biofilms

Superficial layer

Deep layer

Activated sludge

Nitrifying bacteria

Denitrifying bacteria

NH\textsubscript{4}+ accumulated

NH\textsubscript{4}+

NO\textsubscript{3}-- accumulated
Carbon Fiber Supply Experiment at the Actual Facility (pre evaluation)

Pig wastewater introduce

Partially supply water by bypass operation (BOD load: 0.3 kg/m³/day)

Wastewater draw-up

Area for testing with carbon fiber

Volume: Approx. 1 m³

6 pieces (90 cm)

Wastewater draw-up

Area for comparison (no carbon fiber)

Volume: Approx. 1 m³

Activated sludge amount
MLSS: 5000 mg/L

Treated water

Aeration 4.8 m³/h

National Agriculture and Food Research Organization
GHG and Water quality comparison

In the carbon fiber (CF) reactor

0.008 g N$_2$O·N/g TN·load

In the activated sludge (AS) reactor

0.021 g N$_2$O·N/g TN·load
Okayama 1 CF reactor setting in the facility
CF reactor setting in the facility (2)
No conclusion, still now runnngnnng..

CF reactor has a great possibility to mitigate, probably.

Both ordinary and CF reactor installed conditions, we need more longer periods of emission data.

We also need to evaluate at the other facilities.

Next chance of some meeting, I would like to present definite results concerning this I hope.
Thank you for your attention