Technologies coping with global and local environmental issues related to livestock development

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Increase in the demand of livestock products in developing countries:

- Nutritional benefits to the people
- Provision of income and increase in economic stability
- Rapid expansion of livestock development likely causes global and local environmental problems

Current developments of technologies to solve such problems based on the Japanese experience

- Use of food waste for animal feed
- Development of technologies on animal waste treatment
- Development of technology on climate change
Use of food waste for animal feed

Economical and Ecological feed

“Ecofeed”

Traditional but new technology

Industrial Food Waste (11 million ton)

Use as feed (21%)

Promotion of the use as feed II
Background

• Self-sufficiency of food 41% (Feed 26%) (2009)
  – Corn import 12 million ton per year
  – Ecofeed as first priority
• BSE incidence and Amendment of Feed Safety Law (2001)
  – Food waste can be fed to swine and poultry
  – No animal materials for ruminants
• Council for improving self-sufficiency of feed (2005)
  – Feed self-sufficiency 24% → 35%
  – Concentrate feed self-sufficiency 10% → 14%
  – Producing ecofeed from food waste
    • 2.5 million ton → 5.1 million ton
Processing of food waste for ecofeed

Distribution

Wide area
Dehydration

Silage

Small area
Liquid feeding

Dehydration
Silage
Liquid feeding
Fermented Liquid feeding system

Food industry
- Collection and formulation
  - Nutritive value
  - Feed formulation

Soup center
- Feed Preparation
  - Heat treatment
  - Use of organic acid
  - Inoculation of lactic acid bacteria
  - Incubation

Pig farm
- Feeding system
  - Feeding system
  - Effect of animals
  - Nutritive value
Integration of Feed Producing Technology

Fermented liquid feeding

High moisture materials
- Shochu (distiller’s) residue
- Cheese whey & milk
- Vegetables residue
- Bio-ethanol residue

Soft grains
- Rice and wheat
- Corn cob mix

Structural reform of feed producing capacity
Animal production and environment

NH₃, CH₄, N₂O, CO₂

NH₃
CH₄
N₂O
CO₂

Water N purification
Buffer zone

Wt N

Diversity

NH₃
CH₄
CO₂

Hojito 2008
**Introduction of the Vacuum Aeration System (VAS)**

Positive Pressure Aeration (Conventional)

High Ammonia Gas Emission!

- 14.4% (N)
- 85.6% (N)

Vacuum Aeration

- <3.5% (N)
- 77.4% (N)
- 19.1% (N)

Reduction of the Ammonia Gas Emission

Chemical Scrubber

- High concentration ammonia gas is scrubbed, and recovered as liquid fertilizer.
- 77.4% (N)
- 19.1% (N)

Now on researching about the utilization of the liquid fertilizer and thermal energy in greenhouse.

Abe et al. 2008
1) Organic matter decomposition is accelerated and thermophilic phase is finish within 4 weeks.

2) Ammonia gas emission from the surface of the pile is reduced to 1 - 10%.

3) 0.94kg of nitrogen is recovered from 1 ton of dairy cow feces by the chemical scrubber.

4) $2.95 \times 10^5$ kcal of thermal energy (estimated 23.8 L of kerosene in calories) is generated from 1 ton of feces.

5) CO2 gas is supplied continuously to the greenhouse.
Summary of the technology for phosphate removal and recovery from swine wastewater.

MAP: Magnesium Ammonium Phosphate

Phosphate (MAP) recovery device

30% MgCl₂ addition enhances MAP crystallization reaction.
Phosphate recovery from swine wastewater

(1) removal of phosphorous for keep environment clean and conformity with law
(2) recovery and recycle of phosphorous as resource

Suzuki et al., 2008
Upflow Anaerobic Sludge Blanket (UASB) Reactor

A granule of anaerobic bacteria, including high concentration of methanogenic bacteria. (2~4 mm in diameter)

Tanaka & Suzuki, 2004
Napier grass production under various application rates of cattle feces (Matsuo et al. 2001)

-Development of sustainable agriculture in Northeast Thailand (JIRCAS)-

Site: Khon Kaen Animal Nutrition Research Center, Khon Kaen, Northeast Thailand

Crops: Napiergrass

Fertilizer application:
- Dried cattle feces: 100 kg N/ha
- Dried cattle feces: 200 kg N/ha
- Dried cattle feces: 350 kg N/ha
- Dried cattle feces: 500 kg N/ha
- Chemical: 0-150-150 kg N-P$_2$O$_5$-K$_2$O/ha
- Chemical: 150-150-150 kg N-P$_2$O$_5$-K$_2$O/ha
- DCF: 200 kg N/ha + AS: 80 kg N/ha

<table>
<thead>
<tr>
<th>Comparison of soil fertility between Thailand and Japan</th>
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<tr>
<td>Total Carbon (g C / kg soil)</td>
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<tr>
<td>------------------------------</td>
</tr>
<tr>
<td></td>
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<tr>
<td>Total Nitrogen (g N / kg soil)</td>
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<tr>
<td>Available Phosphorus (mg P / kg soil)</td>
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</table>
Crop-Animal Integration

Animal waste: precious resource

Improvement of soil fertility

Improvement of crop-animal production and its sustainability

Improvement of farmer’s income
Research issues of global warming in animal production

Methane(CH₄) and nitrous oxide (N₂O) are potential greenhouse gases produced from animal production system.

1. Development of the technology to estimate CH4 emission from ruminant accurately and to reduce the amounts of the gases emitted from animal production.

2. Development of the technology to estimate greenhouse gas emission from animal waste treatment

3. Evaluation of the effect of increase in ambient temperature on animal production

In the Kyoto Protocol (1997), our country promises greenhouse gas 6% reduction.

Mikaloff Fletcher et al., 2004

Agriculture is main methane gas source.
Spatial distribution of the declining degree of broiler meat production in current and 2060’s August.

Current 2060’s

By the combination of the database of “Climate Change Mesh Data (Japan)” and the data on the relation between ambient temperature and meat production, geographical differences of the climate change on meat production in Japan were examined. (Yamazaki et al. 2006)
Research for control of greenhouse gas emission

Methane reduction by improvement of productivity

(a) CH$_4$ emission per kg fat corrected milk (FCM)

(b) CH$_4$ emission per kg daily gain (DG)

The relationship between productivity and methane (CH$_4$) emission
Methane Reduction by feeding management

Feeding calcium salts of fatty acid

Cost analysis of feeding calcium salts of fatty acid to beef cattle (Yen)

<table>
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<th></th>
<th>Control</th>
<th>Experiment</th>
<th>Difference</th>
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<tbody>
<tr>
<td>Feed cost</td>
<td>86035</td>
<td>119841</td>
<td>33806</td>
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<td>Carcass price</td>
<td>482820</td>
<td>517400</td>
<td>34580</td>
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</table>

Shiba et al., 2003

Feeding sweet potato

Feed intake (kg/day)

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<thead>
<tr>
<th></th>
<th>Hay</th>
<th>Sweet potato</th>
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</thead>
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<tr>
<td>DM intake</td>
<td>6.9</td>
<td>8.6</td>
</tr>
<tr>
<td>Hay</td>
<td>6.9</td>
<td>3.1</td>
</tr>
<tr>
<td>Sweet potato</td>
<td>-</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Methane production per fat-corrected-milk (FCM) yield

Shioya et al., 2001

Shiba et al., 2003
Collaboration between JIRCAS & Dept. Livestock Development of Thailand
Establishment of a Feeding Standard of Beef Cattle and a Feed Database for the Indochinese Peninsula

Distribution of gross energy consumed:

- **Heat**: 30-50%
- **Methane**: 6-10%
- **Feces**: 30-40%
- **Urine**: 3-5%
- **Body tissue**: (-10)-10%
- **Feed**: 100%
Measurement system of green house gas from animal waste treatment

From composting

From slurry storage

Fresh air was introduced and exhaust gas was removed through an outlet placed on top of the chamber.

Gas monitor

National Institute of Livestock and Grassland Science, Hokkaido Animal Research Center, Okayama Prefectural Center for Animal Husbandry & Research, and Kumamoto Prefectural agricultural Research Center
Reduction of GHG from animal waste treatment

- CH$_4$ & N$_2$O emission can be reduced by decreasing moisture content of the pile manure (Osada et al., 2005).

- CH$_4$ and N$_2$O emission from composting can be lowered by strong forced aeration (Osada & Kuroda, 2000).

- N$_2$O emission from wastewater treatment can be reduced with Intermittent aeration (Osada, 2003).
Conclusion

- Importance of resource-recycling type animal production
  - The use of locally available feed resources
  - Upgrading of animal waste treatment and its recycle use
- Transfer of technologies to developing countries
  - Modification of technologies suit to the field
- Importance of collaborative research on sustainable animal production
  - Resource-recycling animal production
  - Technological development for the mitigation of global warming

We are sharing common risk
Transboundary problems to be solved