

Livestock manure processing methods and the use of processing by-products in Japan

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INTRODUCTION

In October 2020, Japan declared its goal of achieving carbon neutrality, which means zero greenhouse gas emissions overall, by 2050. In the field of agriculture, one of the goals is to promote the use of livestock manure, a biomass resource, for compost and energy. Livestock raised in Japan are mainly cattle (both dairy and also beef), pigs, and chickens (both egg laying hen and also broiler) and about 80 million tons of livestock manure is discharged every year in Japan, which accounts for 20% of Japan's industrial waste. Livestock farmers generally own their manure processing facilities in accordance with the Livestock Wastes Law, and a large percentage of livestock manure is consumed as fertilizer by farmers. In recent years, international prices of raw materials for chemical fertilizers have risen sharply, and fertilizer prices have also skyrocketed in price. Under these circumstances, livestock manure has been attracting attention as a biomass resource, but there is little information on the progress in processing technology of livestock manure, different processing methods by the type of livestock manure, and the use of processing by-products. The aim of this survey is to interview livestock farmers (LF) and livestock manure processing company (LMPC) about the information above, and to summarize the livestock manure management process in Japan.

METHODS

Interviewed LF and LMPC

We selected 6 LF and 13 LMPC for interview. The number of survey sites are shown in Table 1. The target livestock manure is described as following; DM (dairy manure), BM (beef manure), PM (pig manure), EM (egg laying hen manure) and BRM (broiler manure).

Question items

The main question items were “moisture content (MC) of manure”, “manure processing methods”, “the use of the by-products”, “the difficulties related to manure processing”.

Table 1. Types of LF and LMPC

LF and LMPC	manure type or processing methods	Number of investigated LF and LMPC
LF	DM	2
	BM	2
	PM	2
LMPC	Composting	7
	Methane fermentation	4
	Waste-to-energy incineration	2

* At the request of the farmer, we did not visit the farm where the EM and BRM were discharged as a measure against infectious diseases in livestock. Information on EM and BRM was obtained from LMPC.

RESULTS

Livestock manure processing methods and the use of by-products by manure type

Table 2 shows how livestock manure is processed by LF and LMPC, and how the by-products are used.

Table 2. Livestock manure processing methods and the use of by-products by manure type

Manure type	MC, %w.b.	Processing methods of manure and the use of by-products
DM	95%w.b.	<ul style="list-style-type: none"> - LF process raw manure by aerobic fermentation to produce compost. - LF apply raw manure or compost as fertilizer on their own fields or use compost as bedding for their dairy cattle. - LF outsource the processing of DM to PMLC which process manure by composting or by methane fermentation. - Digested liquid generated by methane fermentation process is sprayed onto LF's farmland by a manure spreader or sold as liquid fertilizer to crop farmers. - Biogas generated by the methane fermentation process is used for gas power generation.
BM	60%w.b.	<ul style="list-style-type: none"> - LF process raw manure by aerobic fermentation to produce compost. - LF apply compost as fertilizer on their fields or sold compost to crop farmers.
PM	>95%w.b.	<ul style="list-style-type: none"> - LF separate manure into solid-liquid and the solid components processed into compost. Compost is sold to crop farmers as fertilizer (some LF provide compost free of charge). - The liquid part is purified and discharged to river by LF.
EM	90%w.b.	<ul style="list-style-type: none"> - LF process raw manure by aerobic fermentation and make compost. Some LF outsource the processing of EM to PMLC.
BRM	<50%w.b.	<ul style="list-style-type: none"> - LF outsource the processing of BRM to PMLC for waste-to-energy incineration. Electricity is sold to an electric power company. Incinerated ash is sold to a fertilizer manufacturer as a raw material for fertilizer. - Some large scale LF have their own incineration plants on their site.

* The above are the results of this survey and are not common to all LF or LMPC in Japan.

Difficulties related to the use of by-products

- There is small market for selling compost because many LF have small connection with crop farmer.
- There is small demand for manure and compost as fertilizer because of the heavy labor for spreading manure, difficulties for manure spreader in getting over the fields ridge and difficulties for large manure spreader in entering a small field.
- Compost producer must prepare the storage space to stock compost almost all year round because most farmers only use fertilizer twice a year.

CONCLUSION

This survey found that while there are some difficulties related to the use of livestock manure by-products, livestock manure processing methods were established for each livestock manure type by LF and LMPC. DM, BM, PM, and EM were mainly composted by LF, while BRM was used in some cases as a raw material for waste-to-energy incineration by LMPC. BRM is considered to be suitable as raw material for incineration due to its low MC, which reduces the energy required for drying. Other livestock manure has a higher MC than BRM, making it difficult to transport, which is thought to be one of the reasons why it is rarely used as a raw material for incinerations.

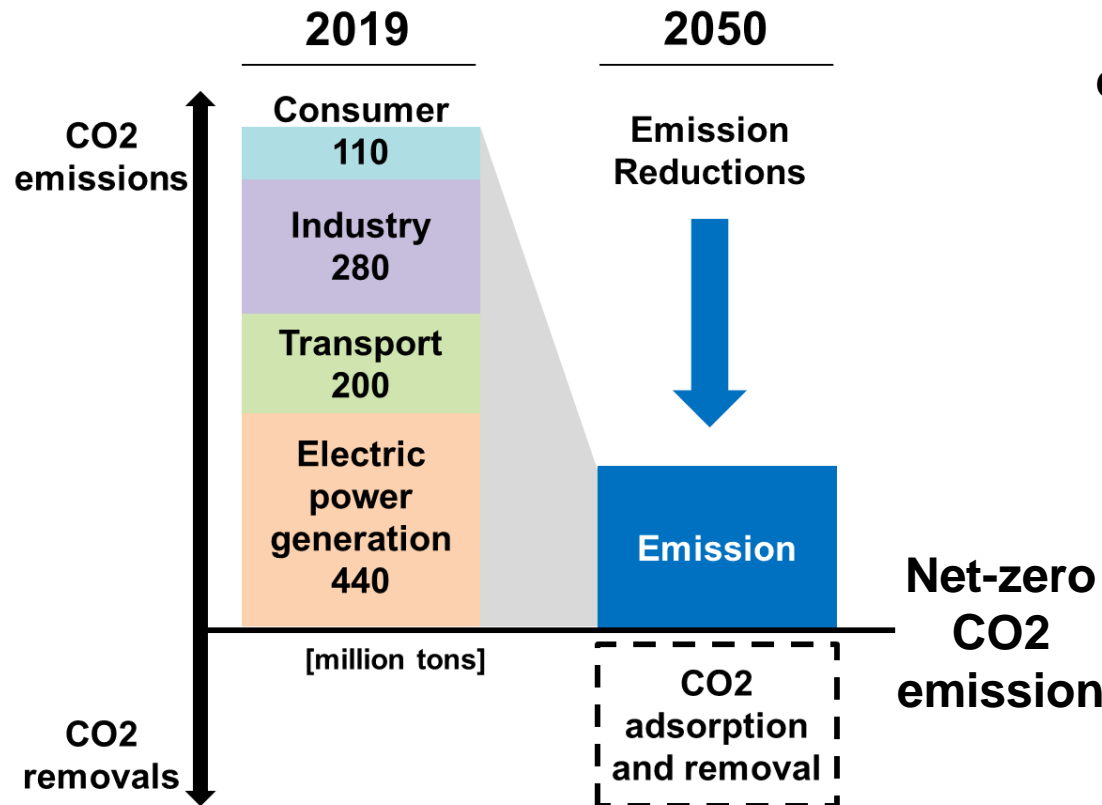
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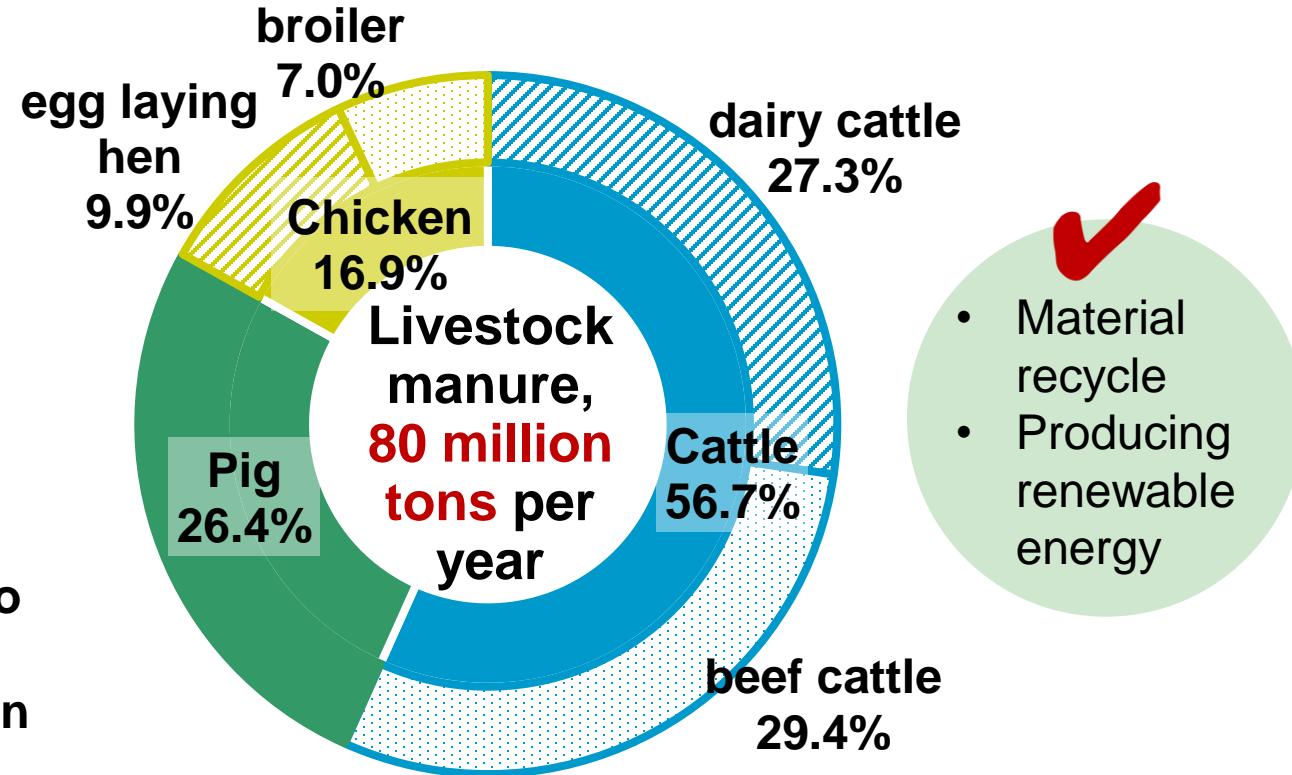
1. Introduction

Japan declared its goal of achieving carbon neutrality by 2050.



GHG emissions generated in 2019 in Japan and GHG reduction targets for 2050¹⁾

Figure based on "Japan's ENERGY (2022 EDITION)"(2022).

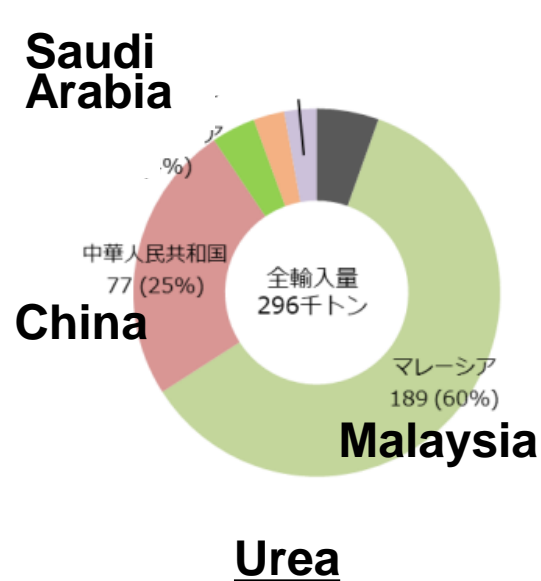


Livestock manure generated in FY2021 in Japan by livestock species²⁾

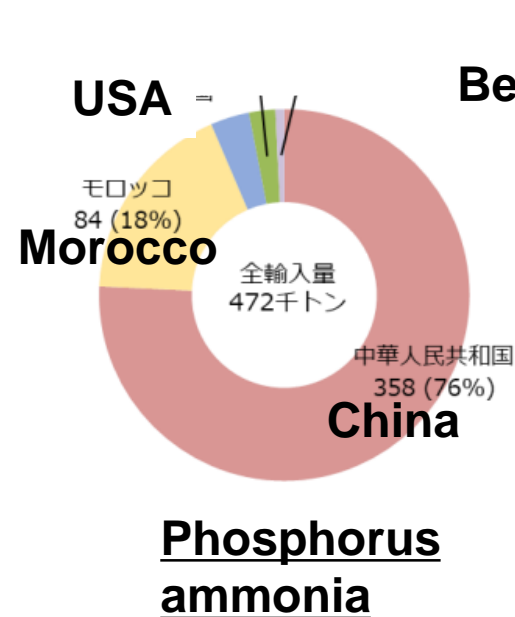
Figure based on "令和4年度事業産業廃棄物排出・処理状況調査報告書令和3年度速報値"(2023).

1. Introduction

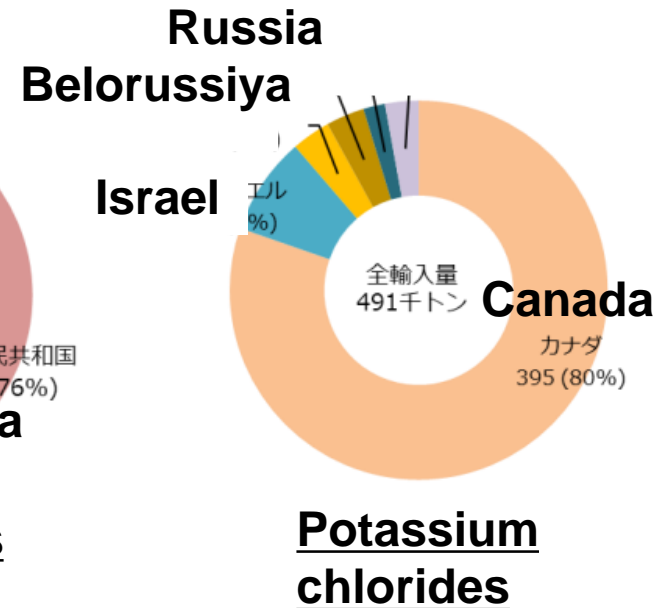
Japan relies on imports of chemical fertilizer raw materials from abroad.



Urea



Phosphorus ammonia



Potassium chlorides

Livestock manure recycling



- ✓ Reduces the amount of waste
- ✓ Stable domestic fertilizer supply

Breakdown of countries from which Japan imported fertilizer raw materials in 2021³⁾

1. Introduction

Research objective

Summarize the livestock manure management process in Japan to understand trends in carbon neutrality in the livestock industry.



What we done

Conducted interview about livestock manure management with both livestock farmers(LF) and livestock manure processing company(LMPC).

Time period for survey 2022/6 ~ 2022/11

Interviewed LF and LMPC

- Livestock farm, **6**
 - Composting plant, **7**
 - Methane fermentation plant, **4**
 - Direct combustion(waste-to-energy) plant, **2**
- } **LMPC**

Interviewed items

- Moisture content(MC).
- How to handle livestock manure.
- How to utilize manure processing by-products.
- Difficulties related to manure management.

Abbreviation

- Dairy manure DM
- Beef manure BM
- Pig manure PM
- Egg laying hen manure EM
- Broiler manure BRM

Moisture content of livestock manure by livestock type

Livestock manure	High MC				Low MC
	DM	BM	PM	EM	BRM
MC, %w.b.	95	60	>95	90	40~50
Number of surveys	2	2	2	0*	



*Due to livestock quarantine measures, we didn't conduct an interview with chicken farmers. Chicken manure MC is based on what was interviewed from the LMPC.

Factors affecting moisture content of livestock manure

- Amount of drinking water consumed by livestock.
- Mixing of dry materials (ex. sawdust).
- Frequency of livestock manure collection.

3. Results

Livestock manure processing methods and the use of by-products

MC	Processing methods		Use of by-products
High	<p><u>Self-processing by LF</u></p> <ul style="list-style-type: none"> • apply to farmland without processing. • Solid-liquid separation. • Composting. • Discharge to river after purification. 	<p><u>Outsourcing to LMPC</u></p> <ul style="list-style-type: none"> • Composting. • Methane fermentation. 	<p><u>Compost</u></p> <ul style="list-style-type: none"> • apply to farmland as fertilizer. • Sell to crop farmer. • Reuse as cattle bedding. <p><u>Liquid fertilizer</u></p> <ul style="list-style-type: none"> • apply to farmland as liquid fertilizer.
MC	Processing methods		
Low	<p><u>Outsourcing to LMPC</u></p> <ul style="list-style-type: none"> • direct combustion. (waste-to-energy incineration). 		 

3. Results

Difficulties related to livestock manure management

- Little interaction with crop farmers, making it difficult to find a fertilizer sellers.
- Compared to chemical fertilizers, compost and liquid fertilizers require more labor to spread.
- Farmland size or dikes are obstacles that prevent large heavy machinery from entering the farm to spread fertilizer.



Little interaction with crop farmers

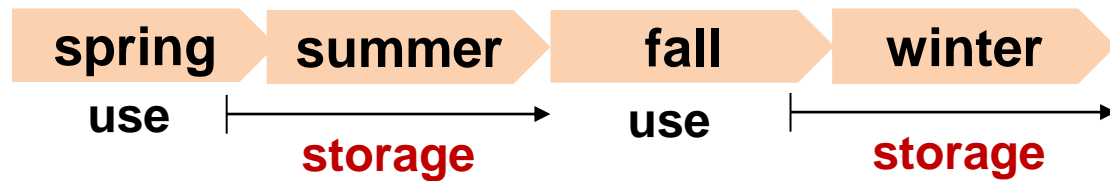


large heavy manure spreader

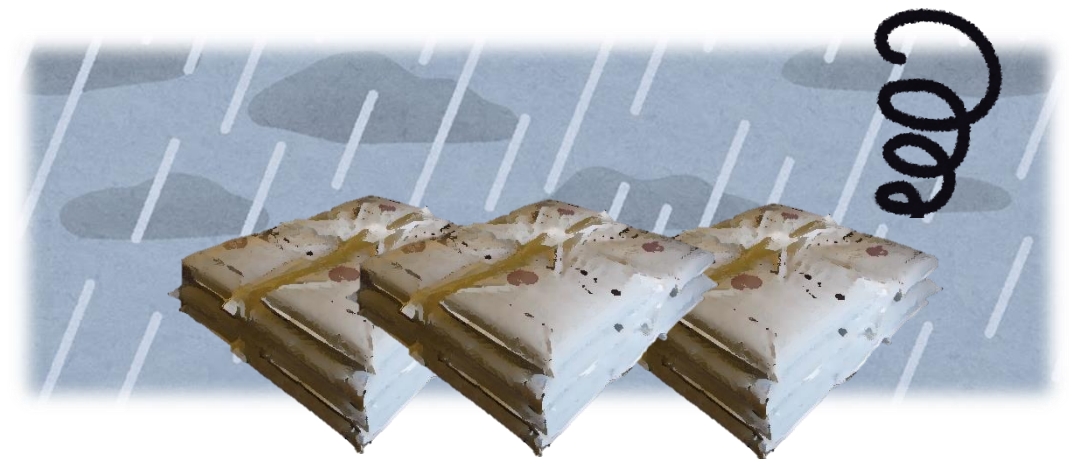
3. Results

Difficulties related to livestock manure management

- Need storage space for fertilizer inventory



- Compost can get wet in the rainy season, reducing the value of the product.



3. Results

Livestock manure processing methods by LMPC

Composting plant



Fermentation tank



Mixing equipment

- Mechanically agitated composting unit.
- Larger-scale processing.
- Wider range of customers for compost.

Methane fermentation plant



Fermentation tank building



Digested liquid storage tank

Digested liquid

- Solid-liquid separation.
- Use as compost or liquid fertilizer.

Biogas

- Generate electricity.

4. Summary

Japan is dependent on imports of fertilizers.

Recycling
of livestock
manure

- ✓ Reduce GHG emissions
- ✓ Contribute to stabilizing the domestic fertilizer supply.

LF and LMPC had established the processing methods for livestock manure recycling systems

- ✓ Composting
- ✓ Methane fermentation
- ✓ Direct combustion

Difficulties related to manure processing by-products

- ✓ Supply
- ✓ Application
- ✓ Storage

5. References

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Thank you for listening.