Analysis of Material and Energy Flow associated with Food Production and Consumption in Japan

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1.Objective

Material flow of food consumption

Nitrogen accumulation in Japanese food system is attributed to increase in food import, increase in chemical fertilizer input, and changes in food consumption patterns (Shindo et al., 2010; Oda, 2006)

Importance of LCT in food system

Life cycle thinking plays an important role in understanding the comprehensive flow of energy, carbon, water, nitrogen, and other important materials associated with the systems for food production/consumption and biomass (food waste) utilization

Evaluation of the material flow associated with food systems, including waste treatment and recycling in Japan

Energy flow

Material flow

Types of "energy"

1. Cumulative non-renewable energy consumption
2. Feedstock energy related to food and biomass
3. Nutritionist's calories of food

2.Methodology

Boundary: Food consumed in Japan
Commodities: 43 commodities
Target Year: 2005
Data on material flow: Statistics, reports
Data on energy use: Statistics, papers, estimation from production cost

Table 1. Commodities

Category	Number of commodity
Cereals	3
Vegetables	14
Fruits	10
Meats	3
Fishes	13

Indicators of energy efficiency in food system

a. Effectiveness of utilization of food waste and co-products (EF_w)

$$EF_w = \frac{EP + AE - EC + FSE_2}{FSE_1}$$

FSE_1: Feedstock energy before treatment/utilization of food waste and co-products
EP: Energy production via utilization of food waste/co-products
AE: Alternative effect of material recycling
EC: Energy consumption during treatment/utilization of food waste and co-products
FSE_2: Feedstock energy after treatment/utilization of food waste and co-products.

b. Energy effectiveness of food supply/consumption (EF_f)

$$EF_f = \frac{FE}{TI - EP - AE}$$

TI: Cumulative non-renewable energy used;
FE: Total energy intake for a food system

3.Results

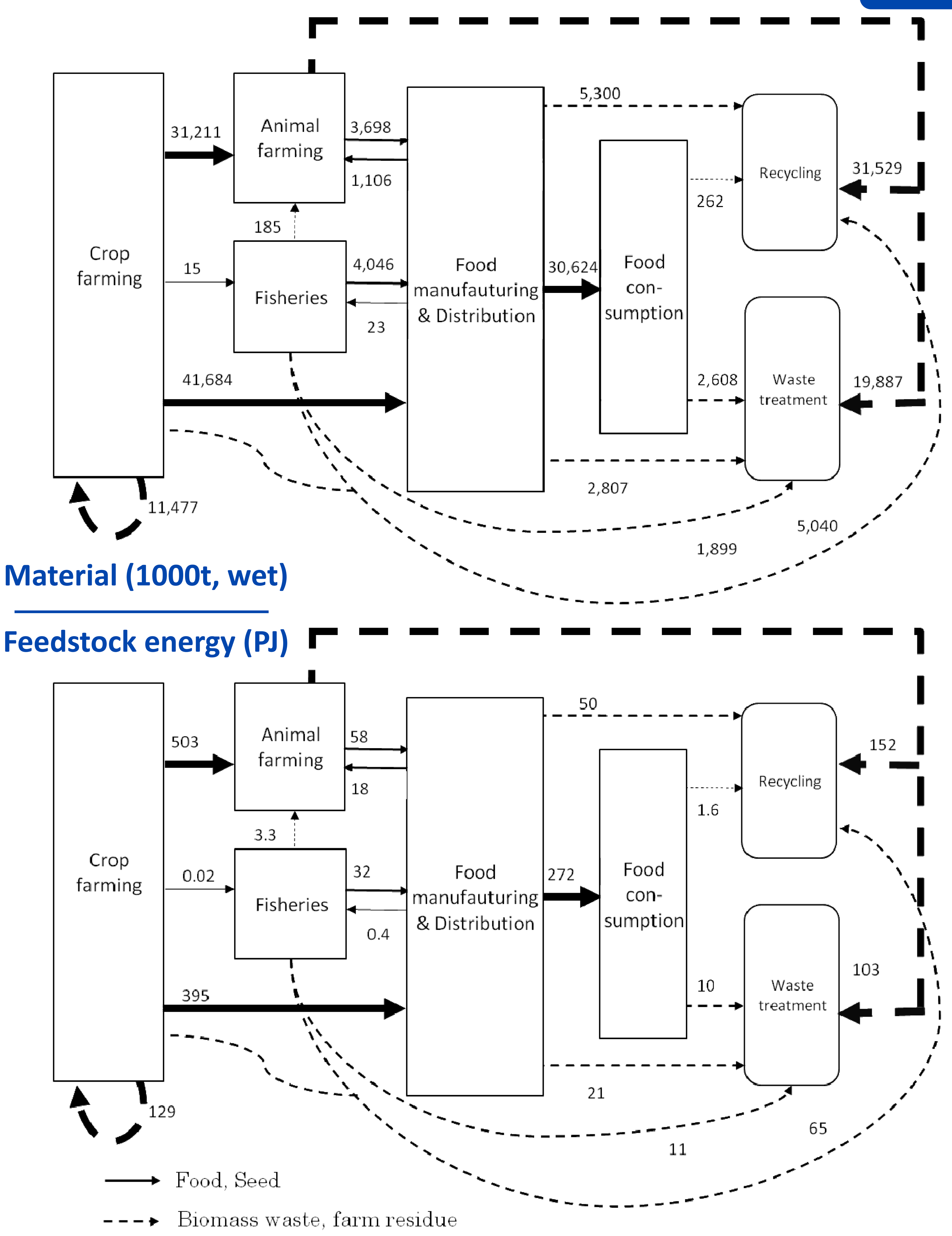

Figure 1. Material and energy flow associated with food production and consumption in Japan ,2005

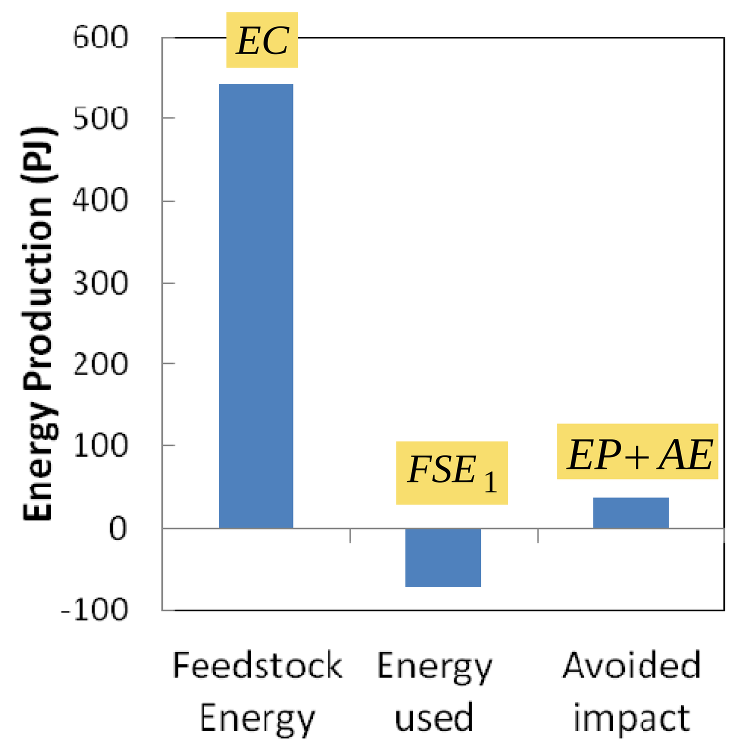

Figure 2. Energy production/consumption of waste recycling/disposal (HHV)

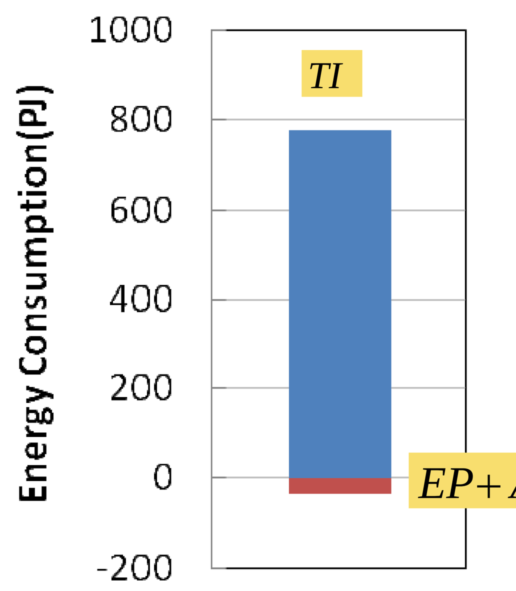

Figure 3. Non-renewable energy consumption in food system

Table 2. Indicators of energy efficiency

	2005
EF_w	-0.6%
EF_f	0.47

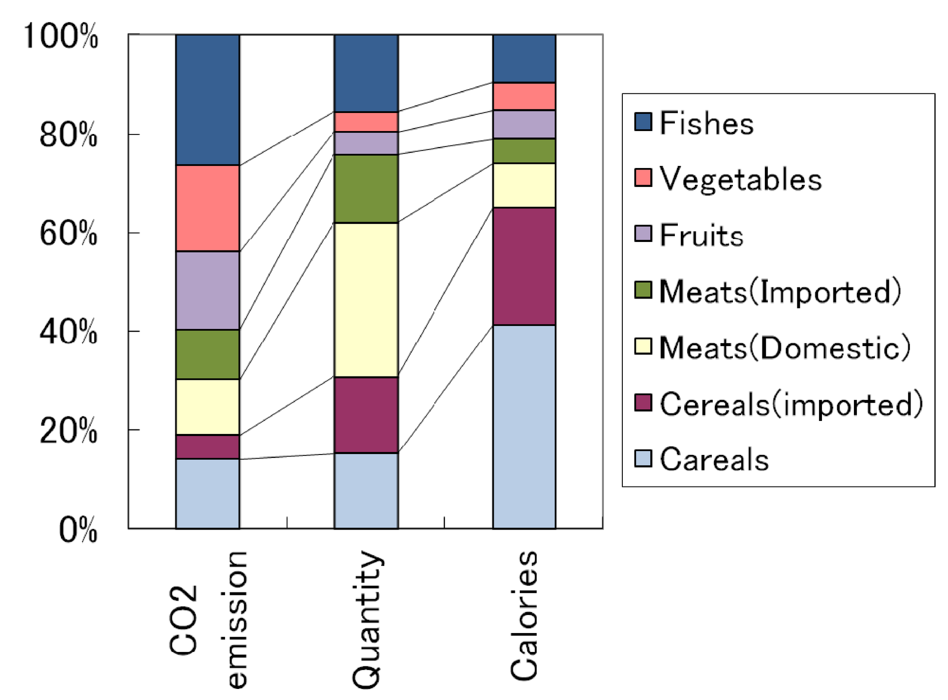

Figure 4. Ratio of emission, energy, and quantity by commodity in major food consumption

- The flow of feedstock energy related to mass flow.
  Primary production per food intake = 2.91
- EF_w is effectd by recycling ratio, recycling method, and content of waste
  → Comprehensive indicator of energy recovery from food waste

- In food system, including waste treatment and biomass utilization, producing 1 cal of food needs 2.13 cal of fossil energy
- Ratio of energy production (containing energy saving by recycling) is relatively small

4.Conclusion

The comprehensive approach in this study can be used to evaluate the effect of active utilization of organic matter, and food recycling policies

Next Step : Analyze suggested indicators theoretically (e.g. determining realizable value)
Expanding model for simulating future diet change, long-term policies, and improvement of agricultural practice