Carbon footprint assessement of Hanwoo (Korean Beef Native Cattle) and options to achieve net-zero emissions

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August 31, 2023 Lyon, France

Introduction

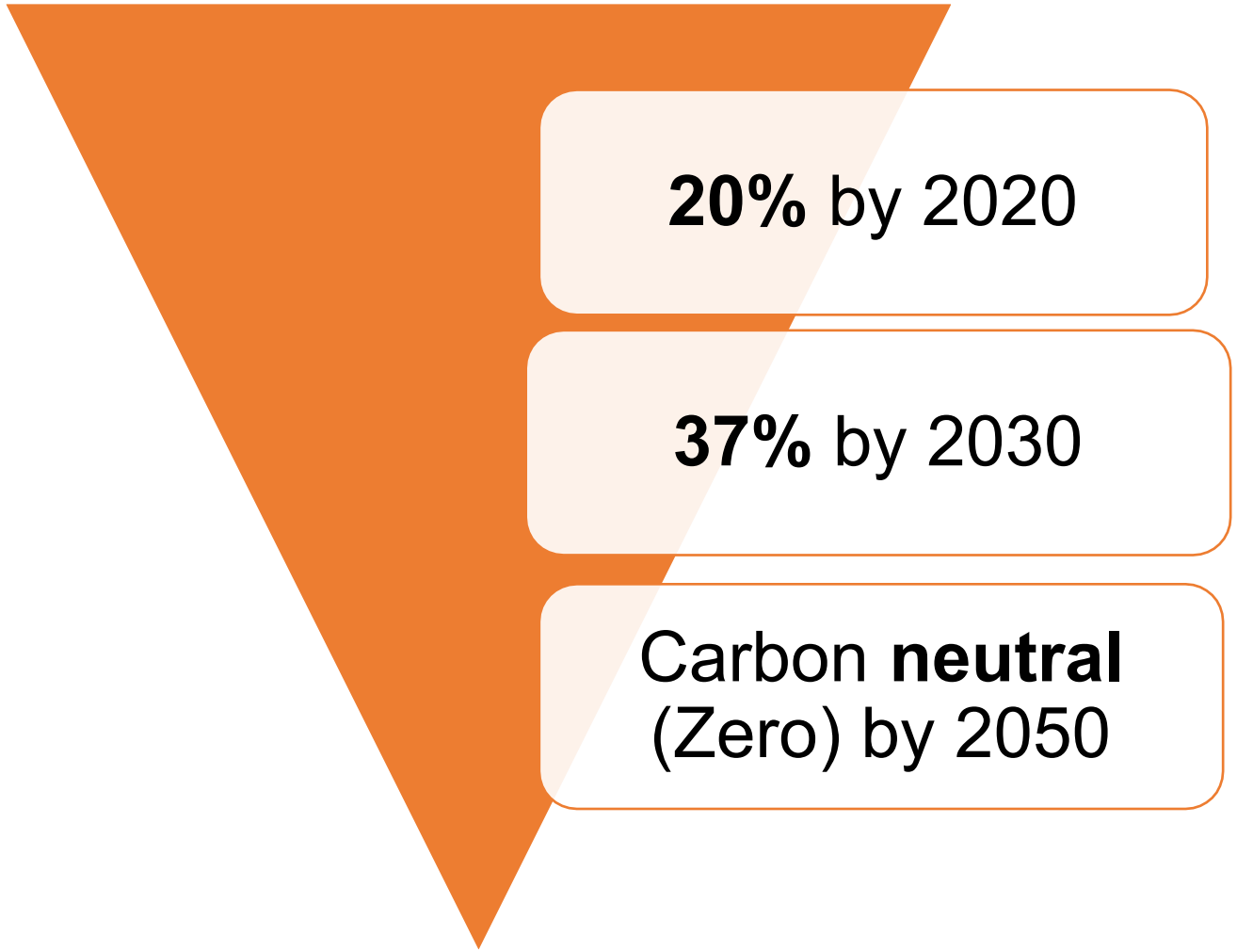
Concept of carbon neutrality

Materials and methods

Results and discussion

Conclusion

Korea GHG emissions reduction roadmap



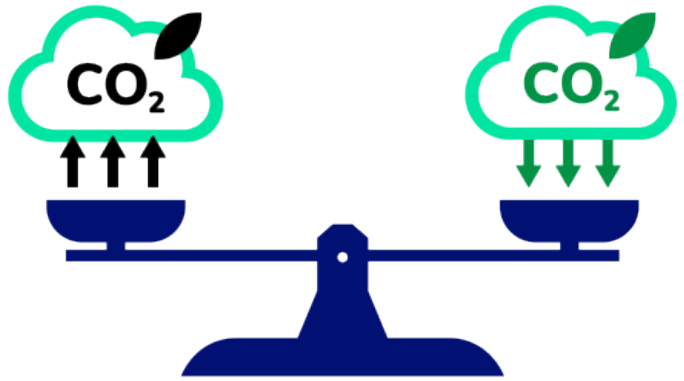
Agriculture sector contributes by **3%** to the total GHG emissions.

What is carbon neutrality?

*Balance between **emitting carbon** and **absorbing carbon** from the atmosphere in **carbon sinks**.*

*Removing carbon oxide from the atmosphere and then storing it is known as **carbon sequestration**.*

*In order to achieve net zero emissions greenhouse gas (GHG) emissions will have to be **counterbalanced by carbon sequestration**.*



Rosa and Gabrielli. (2023)

The Hanwoo beef industry

Premium meat with high marbling score.

3.07 million in 2021 (more than 86% of the total beef cattle).

Fattening production system.

Shortage in arable lands.

95% of imported feed.

Average farm size = 120 head

Hanwoo showed higher enteric GHG emissions than other breeds

Won et al.(2020)

Korea goal Maintain herd size to meet internal meat demand

Objectives

1. Assess the CF of Korean native beef cattle (Hanwoo) and the GHG profile
2. Quantify the CF uncertainty in inputs data
3. Evaluate a global farm scenarios to reach the carbon neutrality

Data collection

3000 Farms

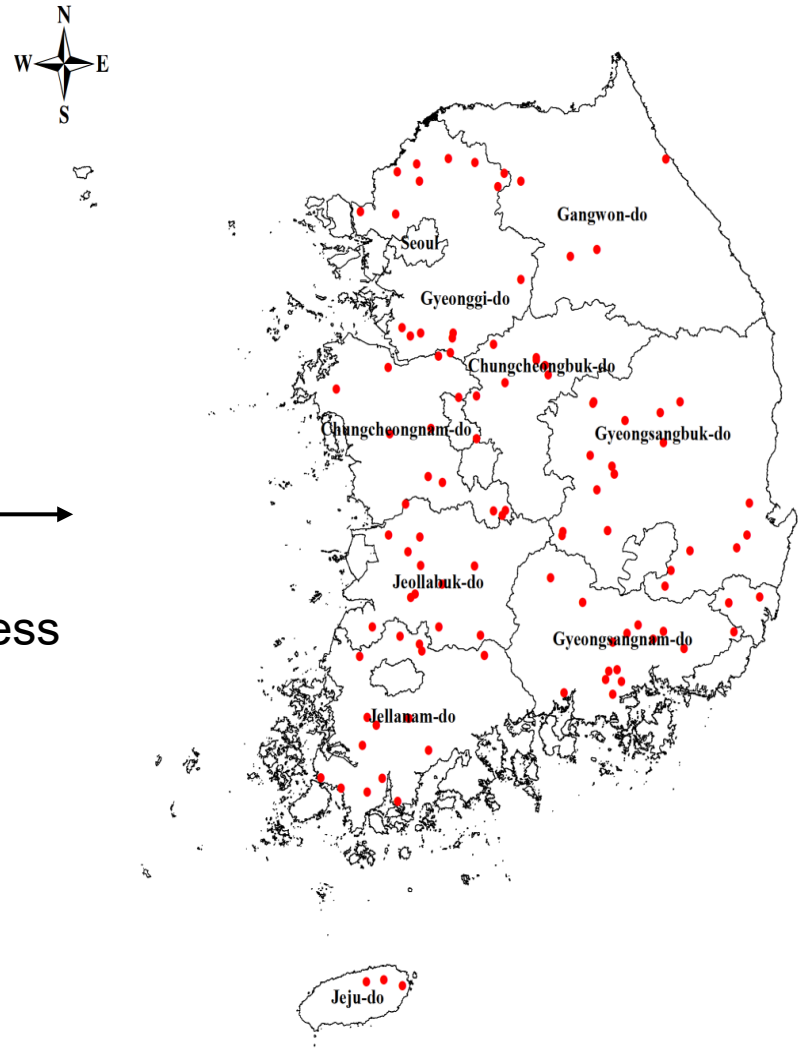
R: random sampling

120 Farms

Filtered for data completeness

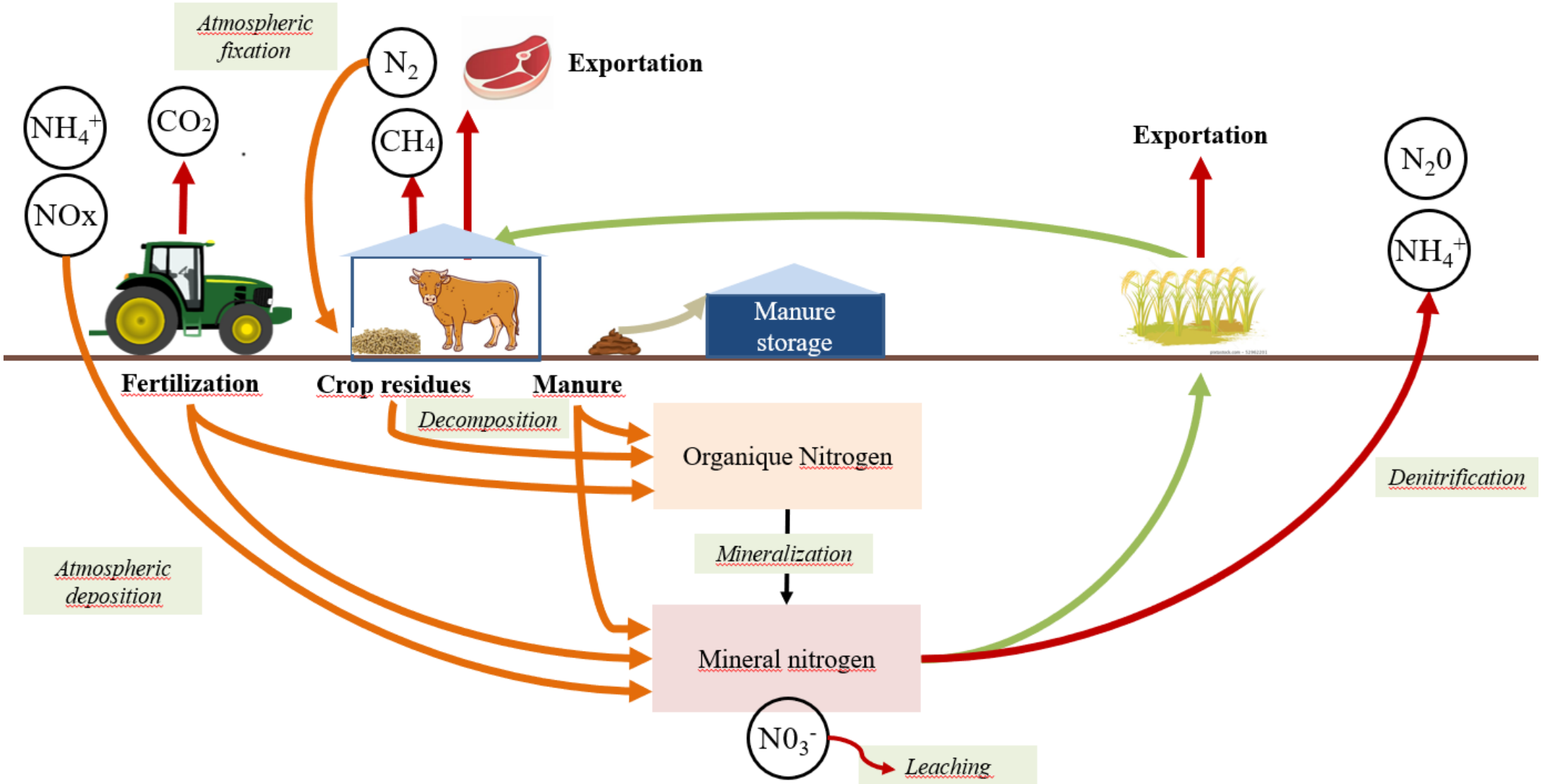
107 Farms

▶ Field surveys from July 2021 to July 2022

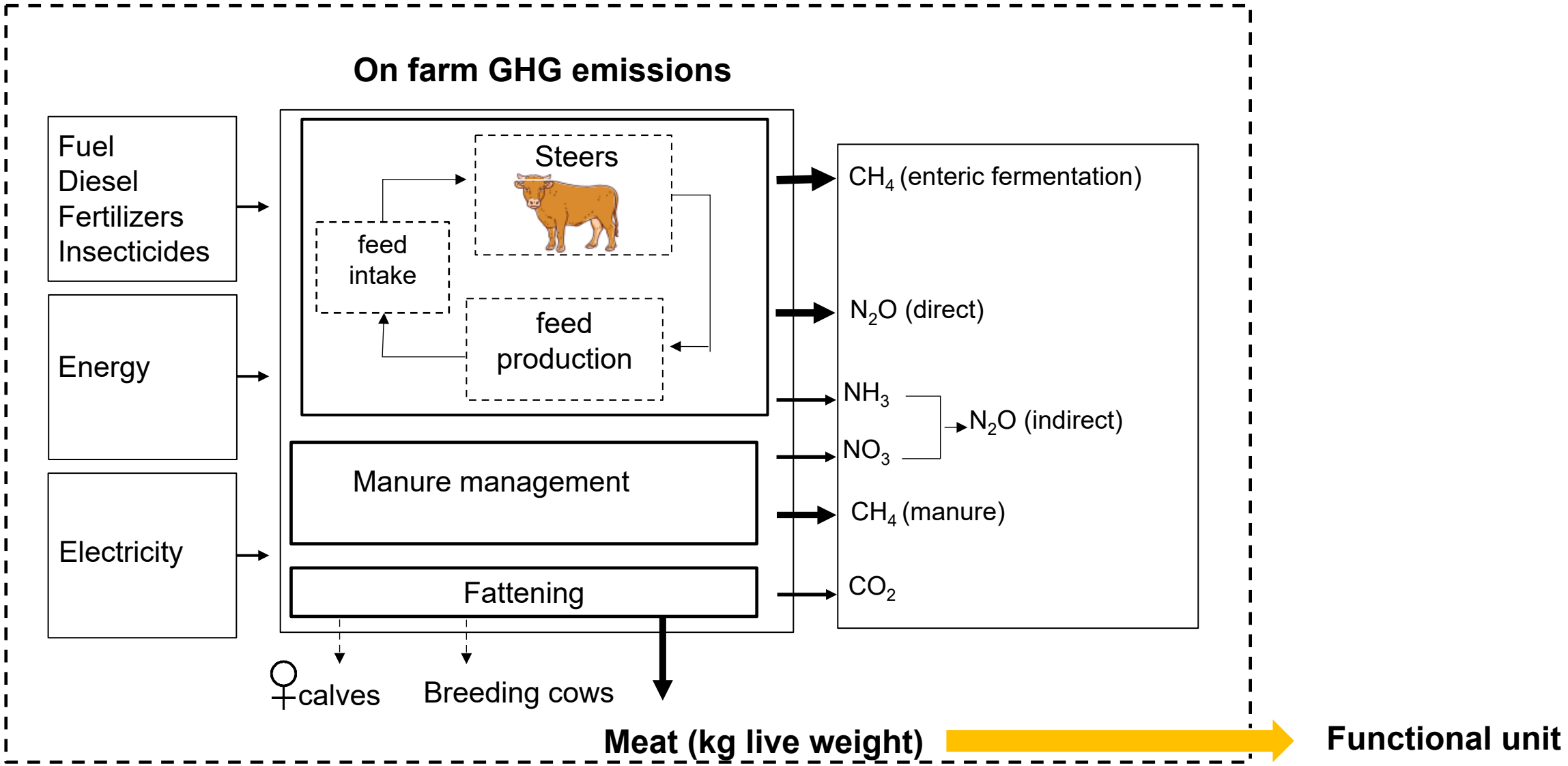


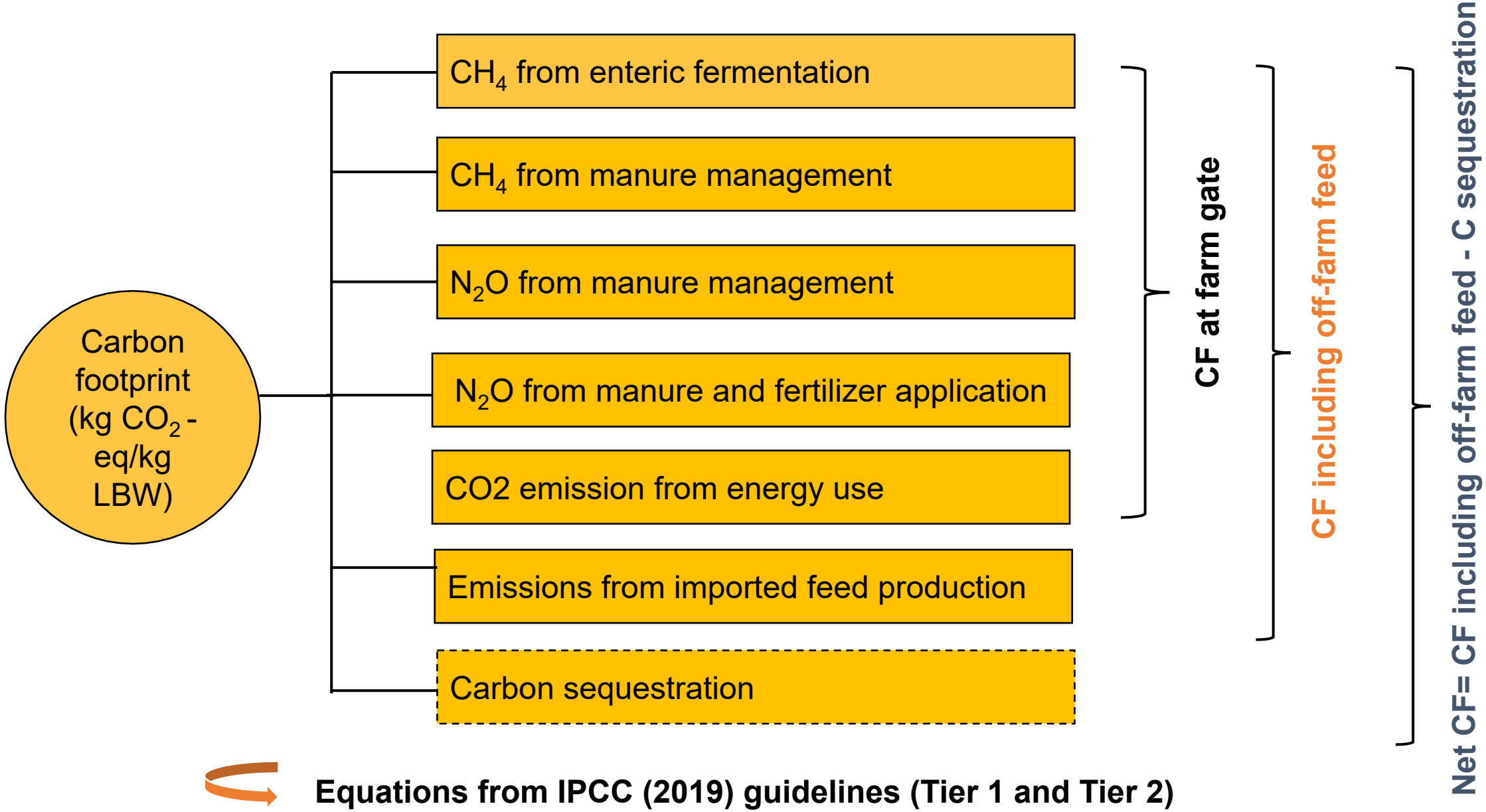
Gyeongsangbuk	19
Gyeongsangnam	18
Gyeonggi	16
Jeollanam	16
Jeollabuk	12
Chungcheongnam	12
Chungcheongbuk	7
Gangwon	4
Jeju	2

Attributional life cycle assessment approach



System boundary and functional unit





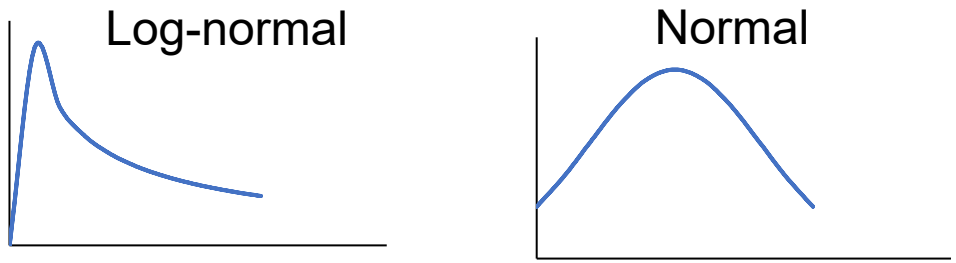
Equations from IPCC (2019) guidelines (Tier 1 and Tier 2)

CF uncertainty of input of the activities data

The Monte Carlo simulation (MCS)

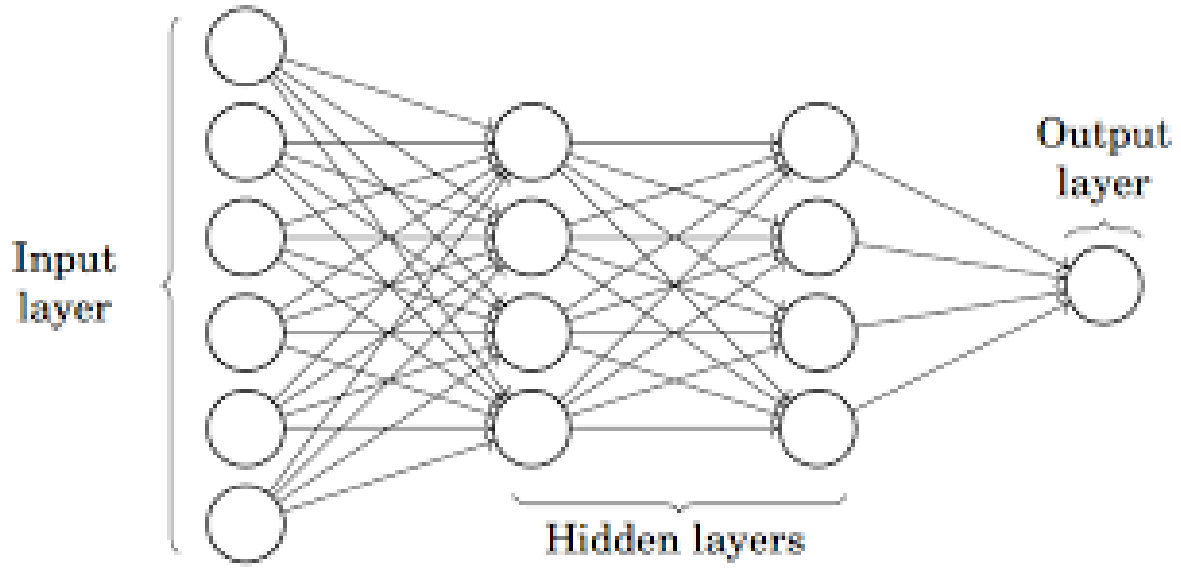
Assign probability distribution function (PDF)

Anderson-Darling goodness-of-fit method
▶ Identify PDF as normal or log-normal



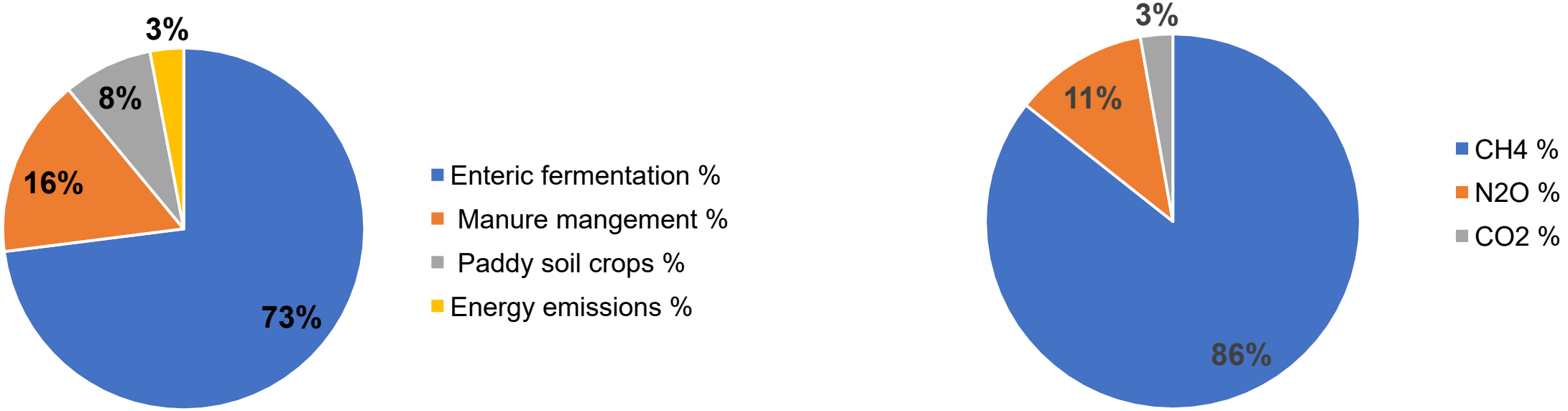
Simulation scenarios formulation

- Maintain the herd size.
- Scenarios were defined based on **the current input data** used to calculate the CF.
- **The coefficient of variation** should be in the **range of what happen in Korea**:
  - Example the feed digestibility varies from 60 to 80%.
- The artificial **Neural Networks (ANN)** were trained **to predict the CF** of Hanwoo meat.
- ANN is a method used for **modelling non-linear relationships** between **input** and **output** variables.

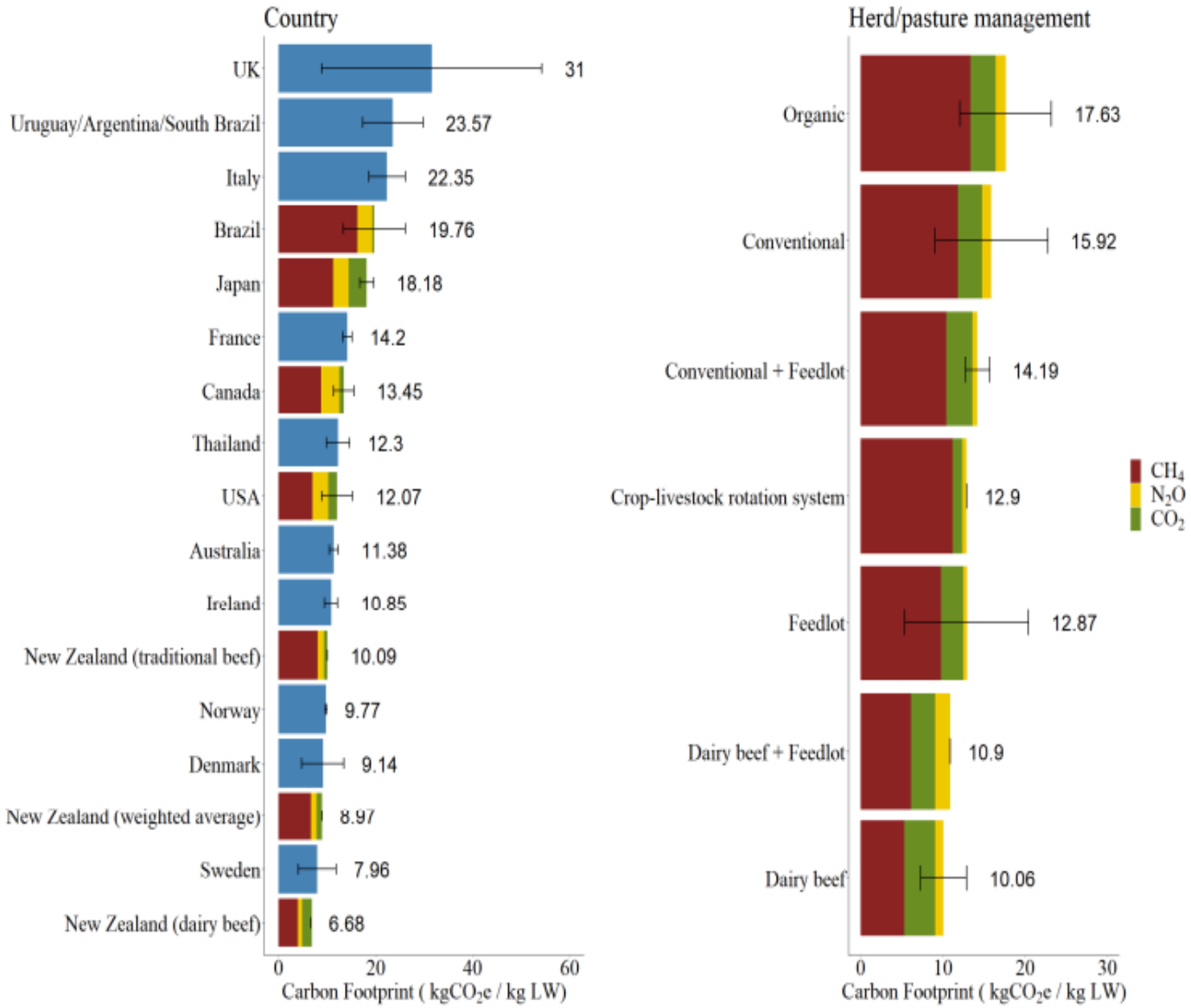


CF of Hanwoo meat screening

8.2 ± 1.75 CO_2-eq/kg of LBW

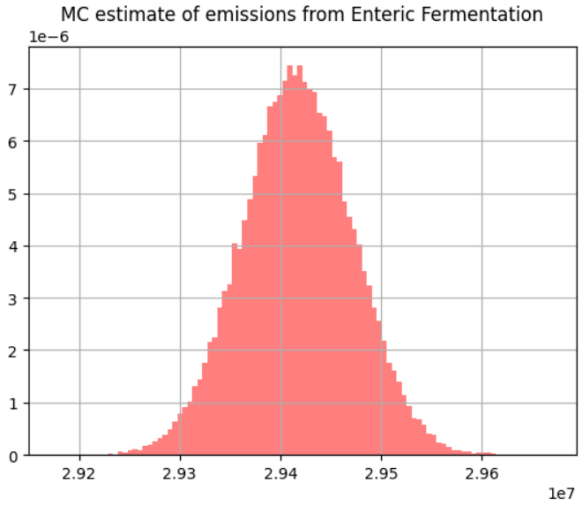


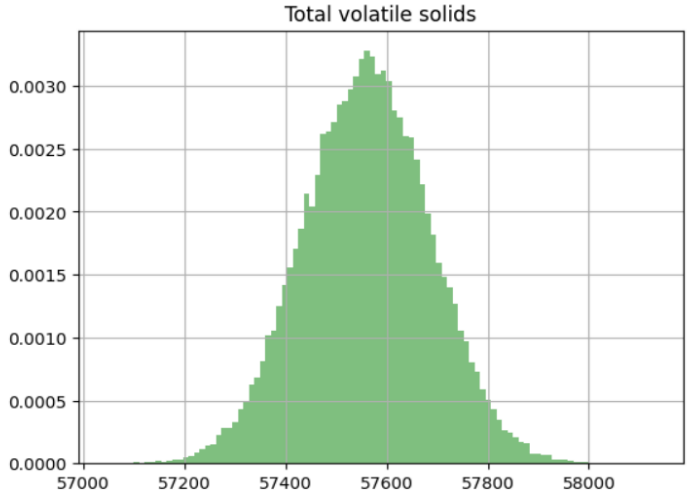
CF of Hanwoo meat screening

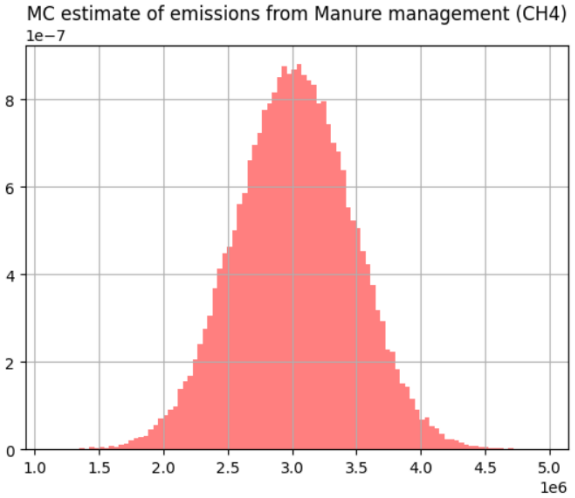


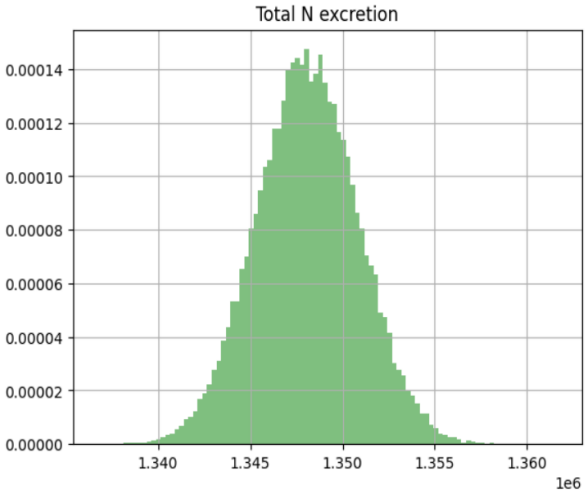
Mazzetto et al. (2021)

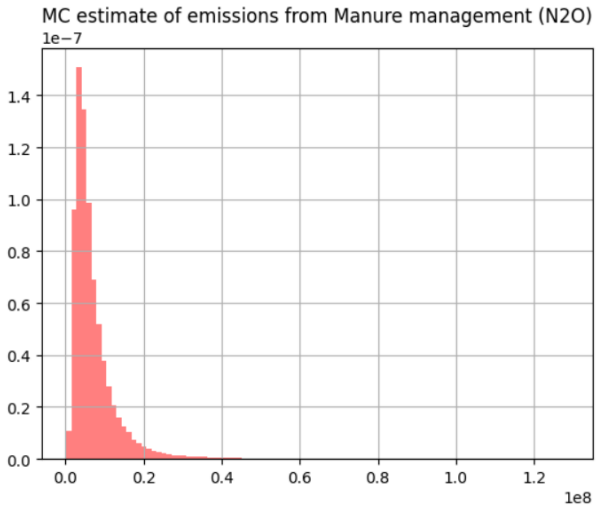
CF uncertainty analysis

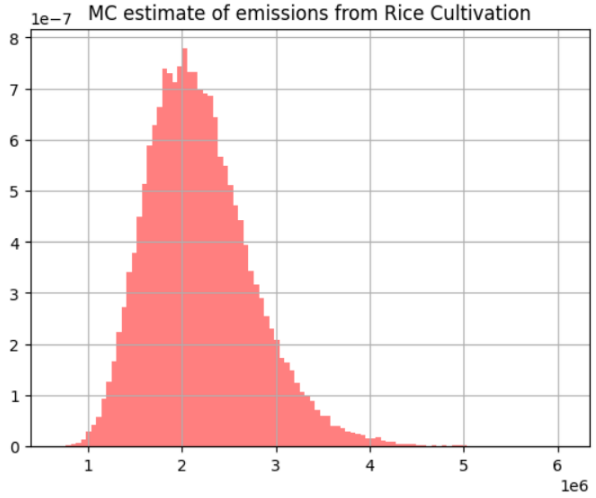






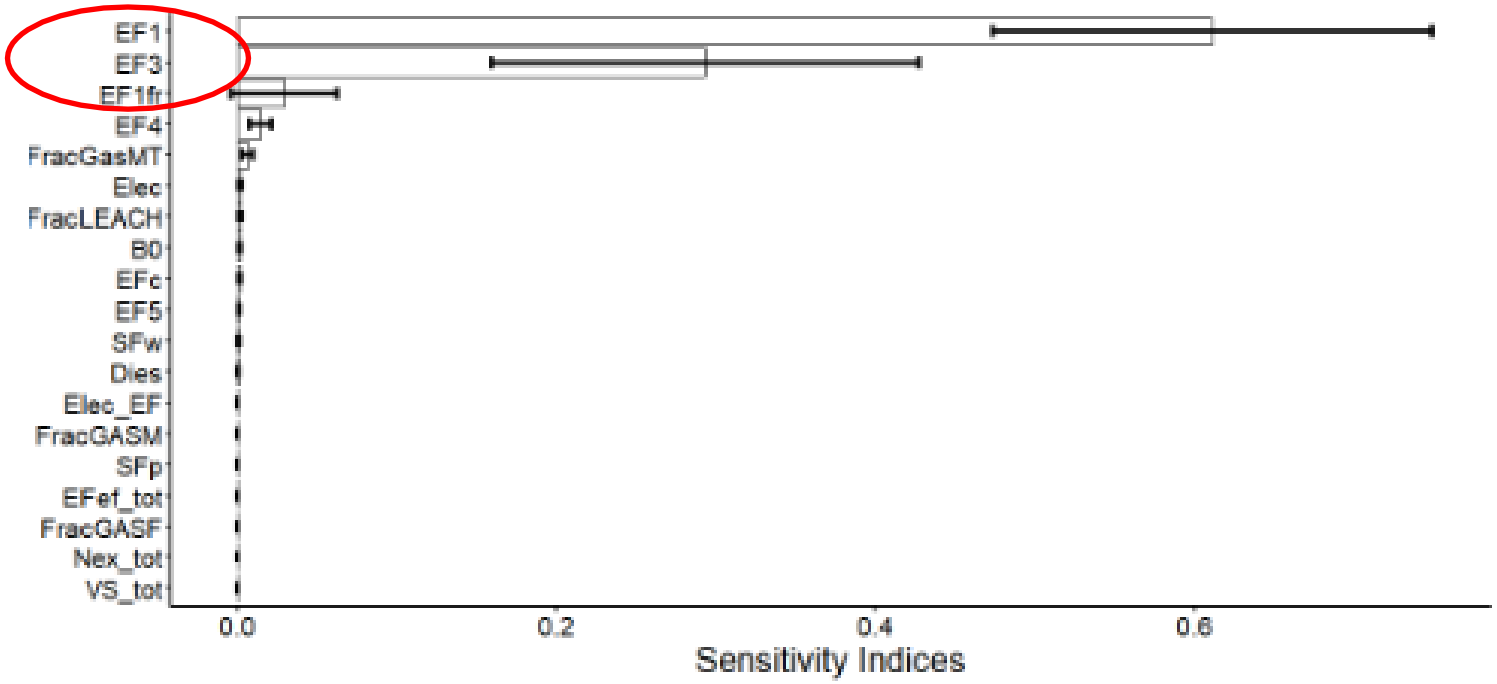






36.6% Uncertainty

Results



36.6% Uncertainty → Emission factors responsible for the high uncertainty

N20

Need for country specific values

CF reduction scenarios

35 randomized scenarios at farm scale

SIMEOS AMG

S1

- ✓ Fattening period (30-26 months)
- ✓ DE% (+ 7%)
- ✓ BW (-15%)
- ✓ DMI (-2%)

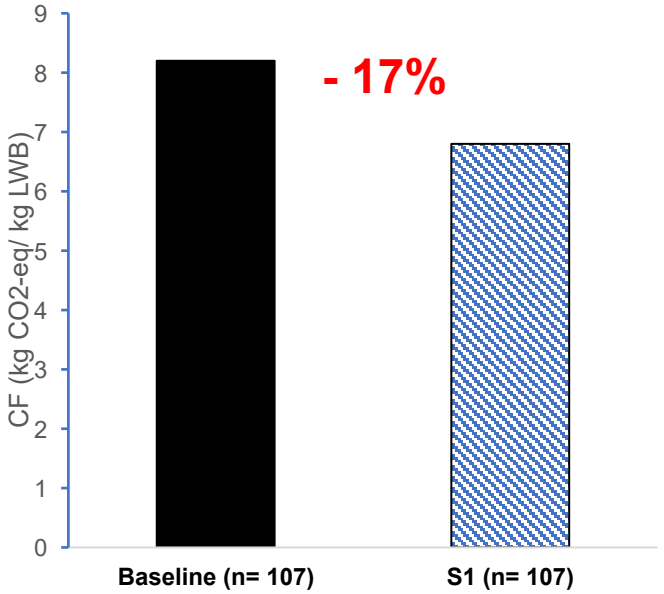
S2

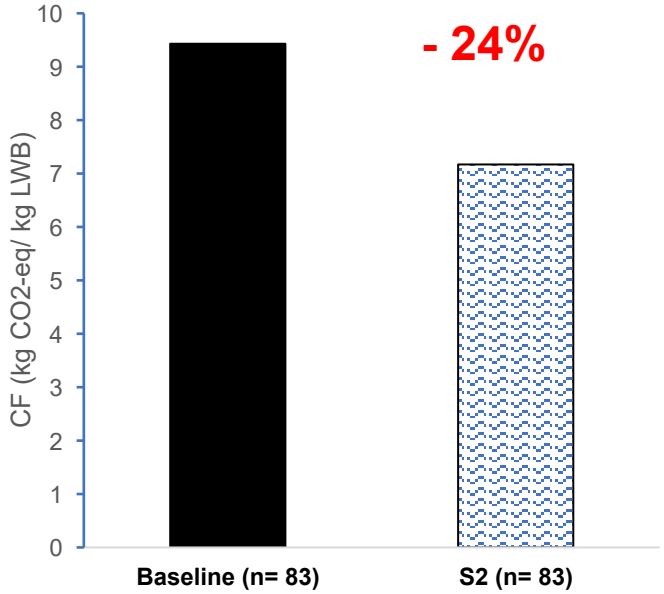
- ✓ Fattening period (30-26 months)
- ✓ DE% (+ 7%)
- ✓ BW (-15%)
- ✓ DMI (-2%)
- ✓ CP (-1%)
- ✓ Manure application rate (-30%)
- ✓ Energy consumption (-2%)

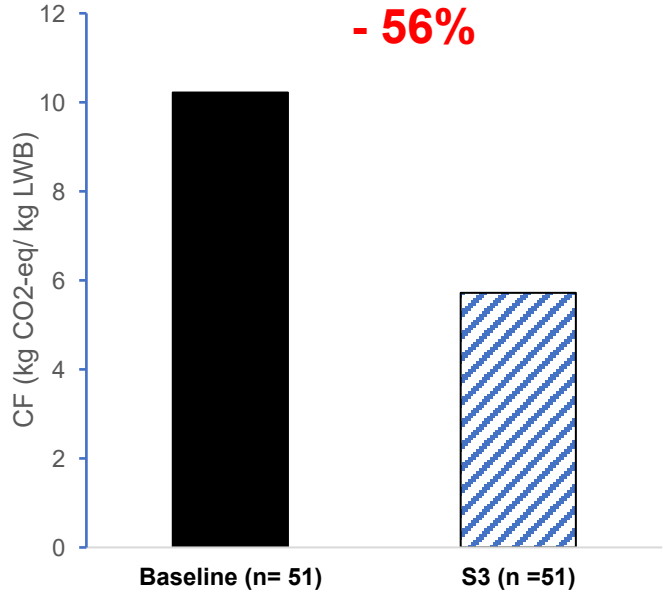
S3

- ✓ Fattening period (30-26 months)
- ✓ Land use size (0 to 0,5 ha)
- ✓ Manure application rate (-30%)
- ✓ Synthetic fertilizer N (-50%)
- ✓ DE% (+ 10%)

CF reduction scenarios







Take home message

CF intensities differs between farms.

Farmers produce the same amount of meat with different emissions intensities or less meat with more emissions.

Develop a specific country emission factors

Synergy between crop and livestock production key factors to reduce the total emissions.

Cost-effective strategies which do not alter the productivity.

Thank you!!