



# HOKKAIDO UNIVERSITY

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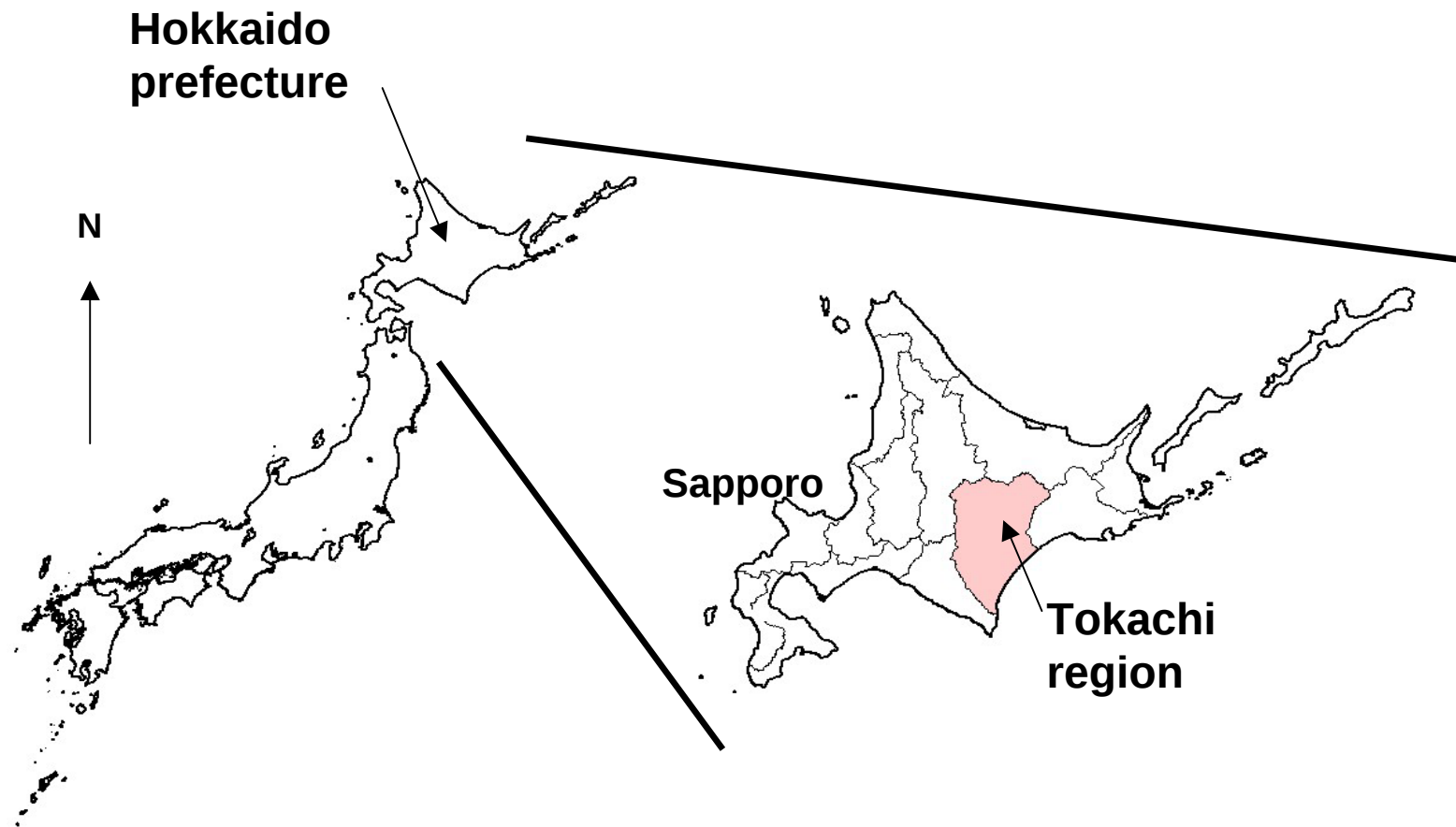
# Life cycle assessment of greenhouse gas emissions from an arable farming system in Hokkaido, northern Japan: Assessing impacts of reducing tillage intensity

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# Background 1: Agriculture in the Tokachi region of Hokkaido



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## Background 2: Tokachi region of Hokkaido



- Agriculture in Tokachi started only 100 years ago.
- Primary region of arable crop production in Japan

Contributions of Hokkaido and Tokachi to national production (%)

|          | Wheat | Potato | Adzuki bean | Sugar beet |
|----------|-------|--------|-------------|------------|
| Hokkaido | 57.9  | 77.3   | 87.6        | 100.0      |
| Tokachi  | 25.5  | 32.0   | 46.3        | 40.2       |

Data in 2006

- Crop rotation system with four crops



## Background 3: Tokachi region of Hokkaido



- Highly mechanized (tractor-based field operations)



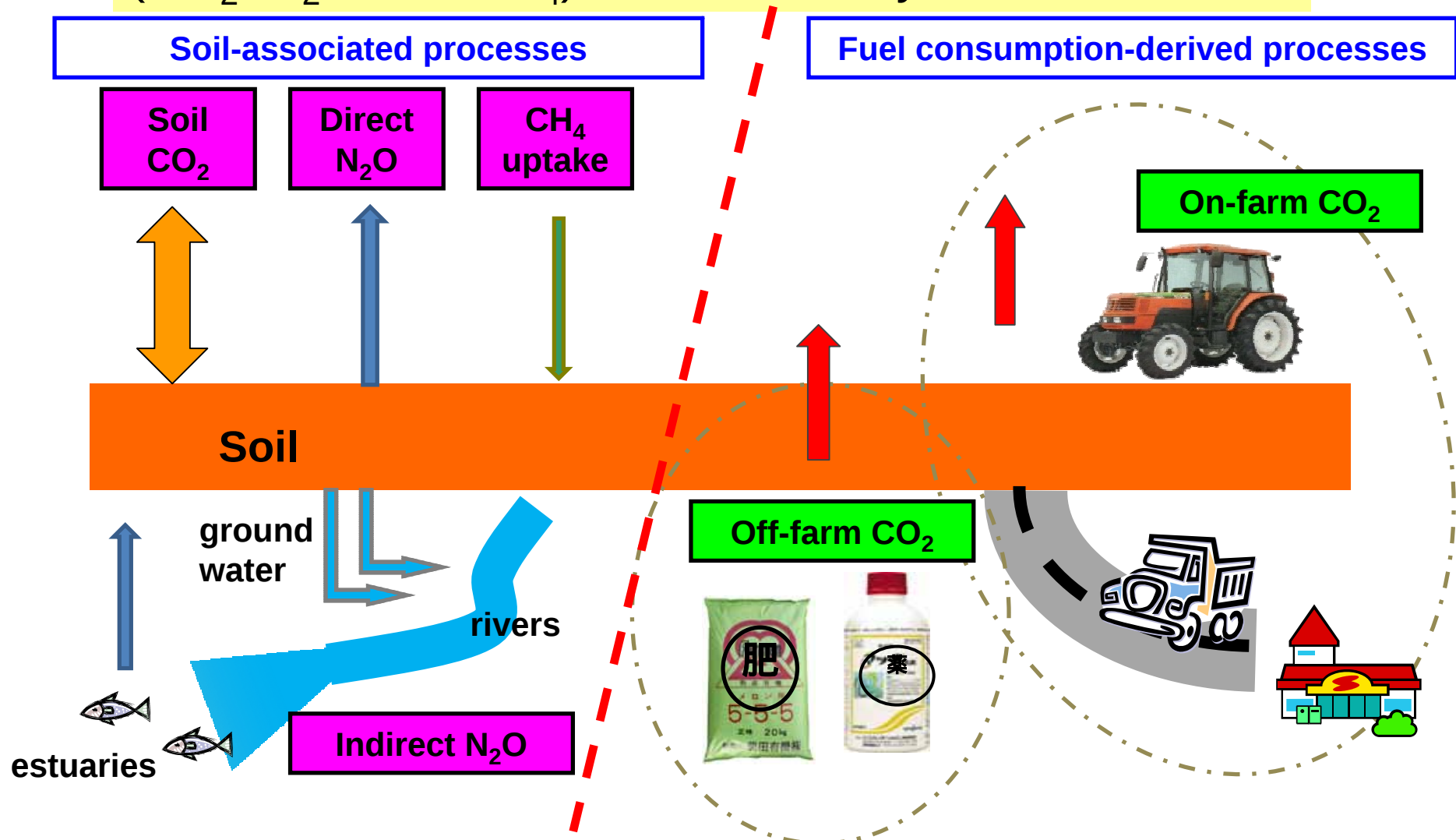
- Intensive (deep and frequent) soil tillage



- Material-intensive (Chemical fertilizer and biocides use)

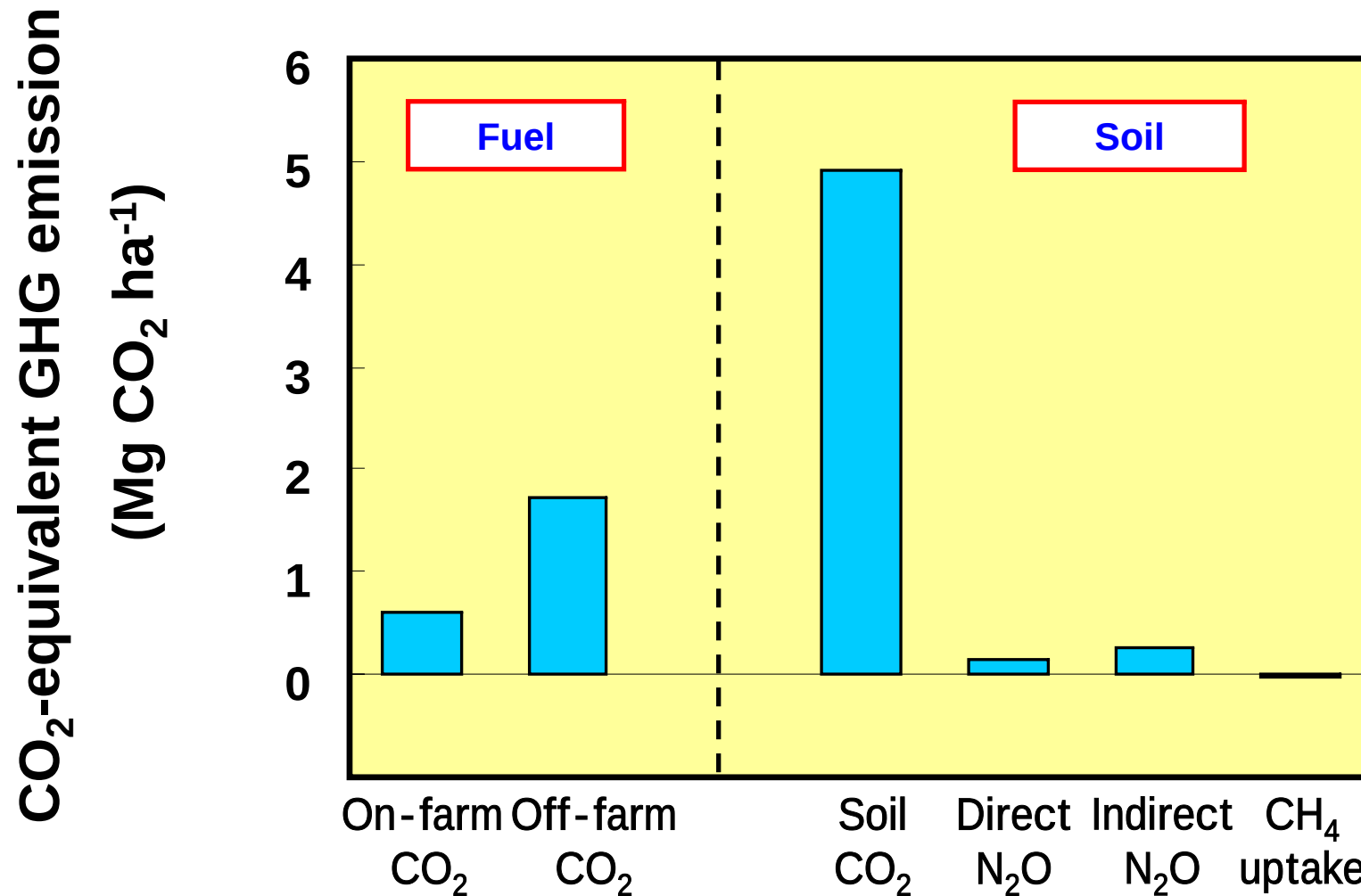
## Background 4: GHG from crop production

In the cropping system, significant greenhouse gas ( $\text{CO}_2$ ,  $\text{N}_2\text{O}$  and  $\text{CH}_4$ ) emissions may occur.



Result :  
Annual CO<sub>2</sub>-equivalent GHG emissions

■ GHG emissions from conventional sugar beet production



# Possible mitigation options

## ■ Conservation tillage

(+) Reduced fuel consumption  
and CO<sub>2</sub> emissions  
(+) Soil carbon sequestration

(-) Weed problem

## ■ Manure application

(+) Soil carbon sequestration

(-) Increased fuel consumption  
for transporting and spreading  
(-) Increased N<sub>2</sub>O emissions

(+) positive impacts

(-) negative impacts

# Tillage operations in Tokachi

## ■ Conventional tillage operations



- ✓ Before sowing (in early spring)
- ✓ two harrowings for soil preparation



- ✓ After harvesting (in autumn)
- ✓ moldboard plow (25 cm depth)

# Implementation of reduced tillage



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Under reduced tillage, no plowing and only one harrowing for soil preparation

- Crop residues overwinter on the ground surface.
- Different soil depths to which crop residues and manure are incorporated
  - $N_2O$  and soil C sequestration ?



Sugar beet residues

# Result:

## GHG from reduced tillage system

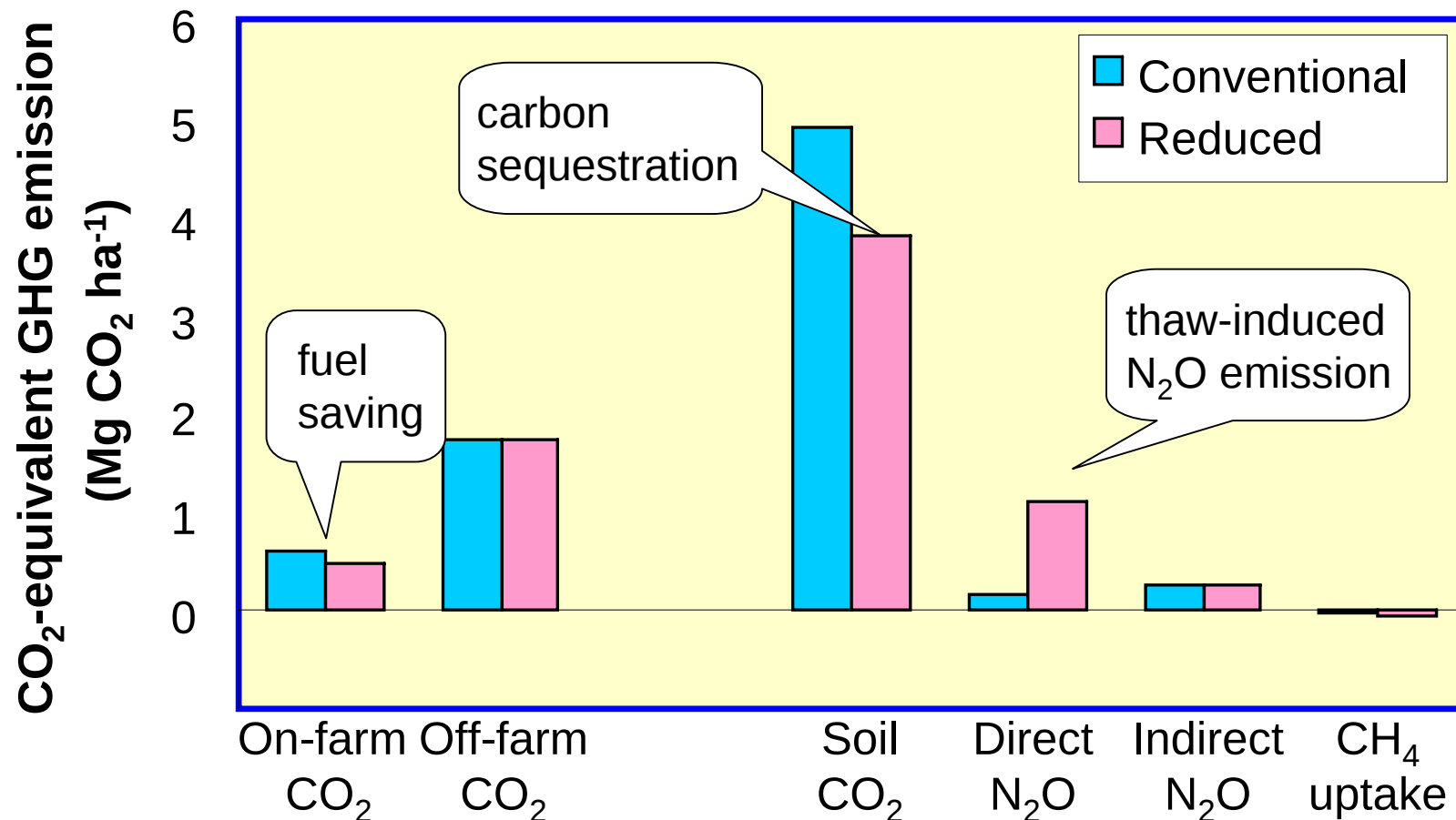


### ■ Implementation of reduced tillage in Tokachi

- Significant reductions in CO<sub>2</sub> from fuels (+)
- Higher soil C sequestration (+)  
(lower soil organic matter decomposition rates)
- In sugar beet, increased annual N<sub>2</sub>O emissions due to large N<sub>2</sub>O emissions during thawing of soil freezing (-)
- 4-18 % reductions of total annual GHG emissions  
by reduced tillage over conventional plow-based tillage,  
depending on the crop type

# Result: GHG from reduced tillage system

## ■ Implementation of reduced tillage in Tokachi



➤ 4-18 % reductions of total annual GHG emissions by reduced tillage over conventional plow-based tillage, depending on the crop type

# Conclusion:

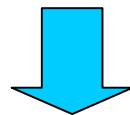
## Trade-off assessment



- Agronomic practices for mitigation are being sought increasingly in the context of global warming

To reduce net GHG emissions from agriculture,

- Trade-offs between CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub>
- Trade-offs between GHG and other factors (crop yields, cost, farmer's working conditions.....)



*future*

- Methodology for trade-off assessment on field, regional and national scales: GIS, models.....
- Inventory data: GHG, crop, soil, climate and management



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Thank you for your attention !