



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

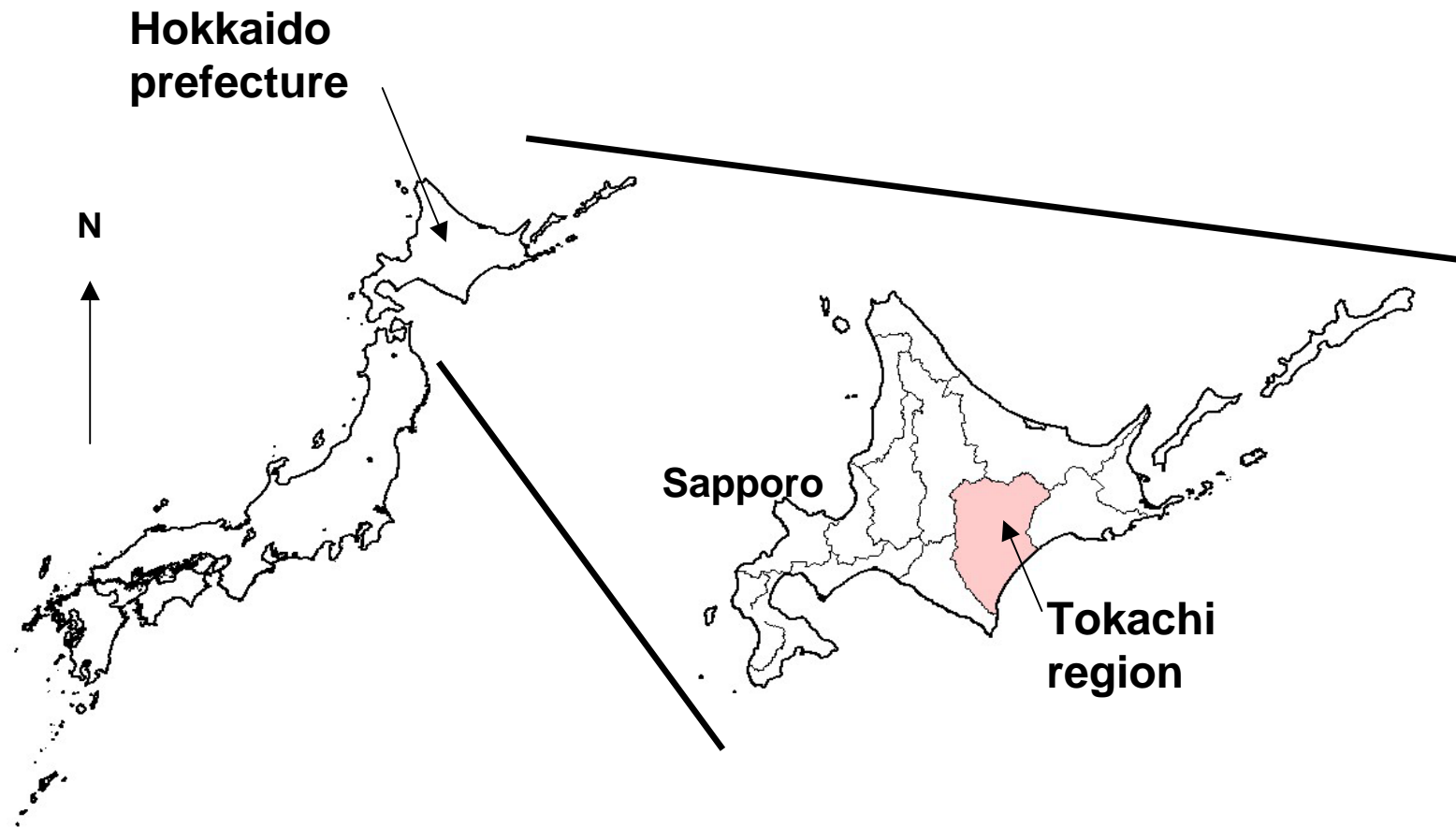
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# Background 1: Agriculture in the Tokachi region of Hokkaido



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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



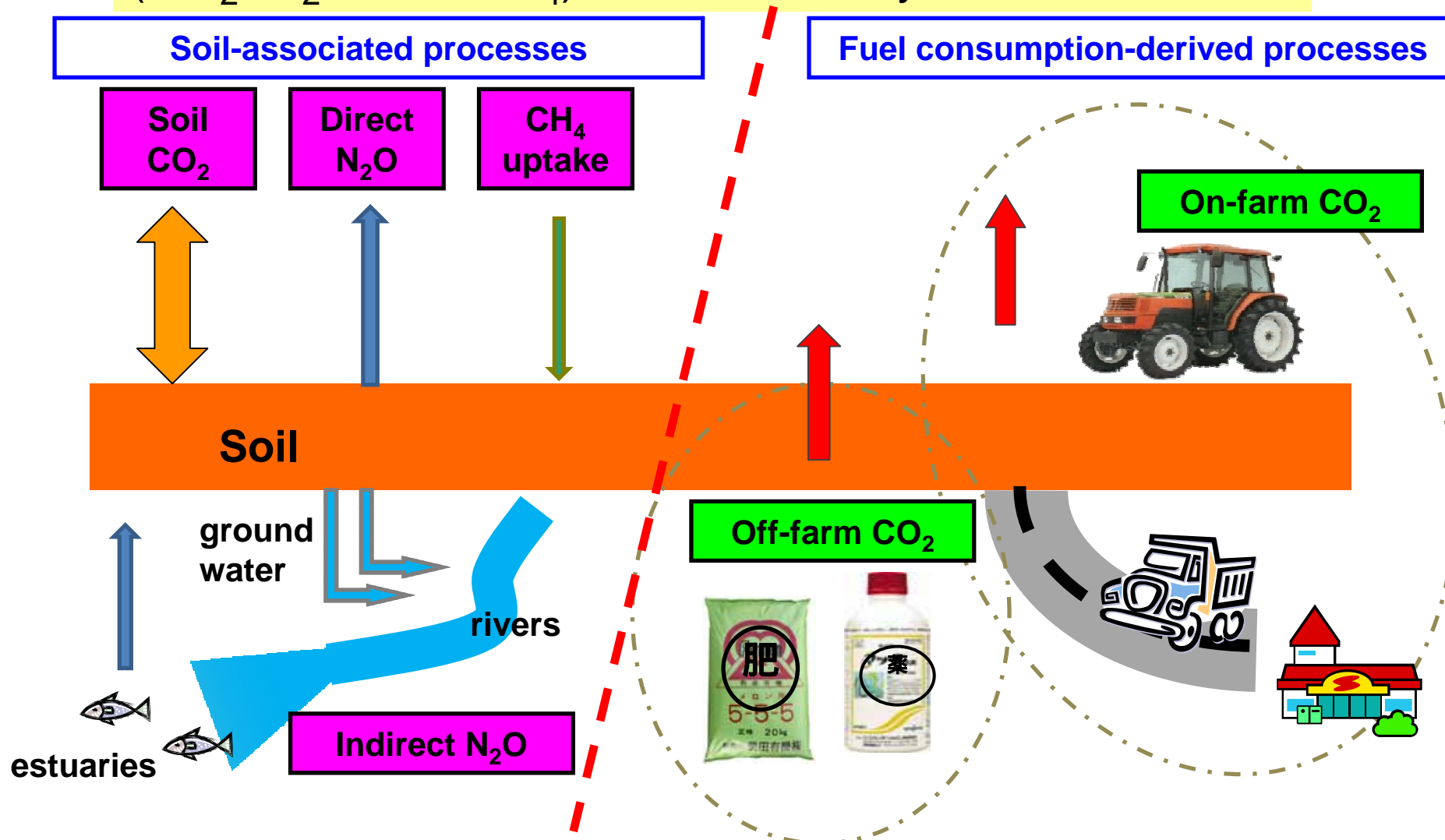
- Material-intensive (Chemical fertilizer and biocides use)

## Background 4: GHG from crop production



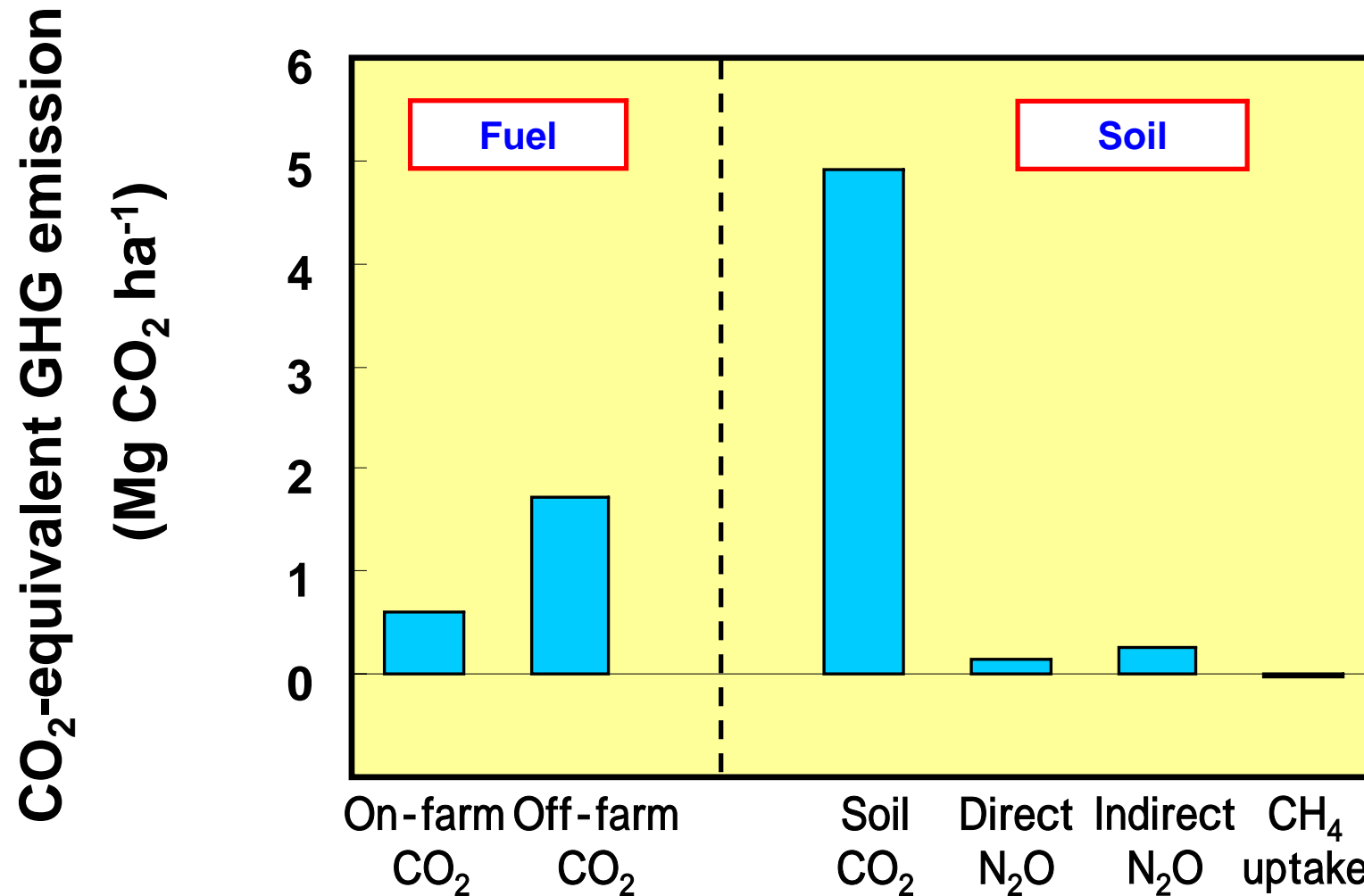
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In the cropping system, significant greenhouse gas ( $\text{CO}_2$ ,  $\text{N}_2\text{O}$  and  $\text{CH}_4$ ) emissions may occur.



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

## GHG emissions from conventional sugar beet production



# Possible mitigation options



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## 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



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## 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

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

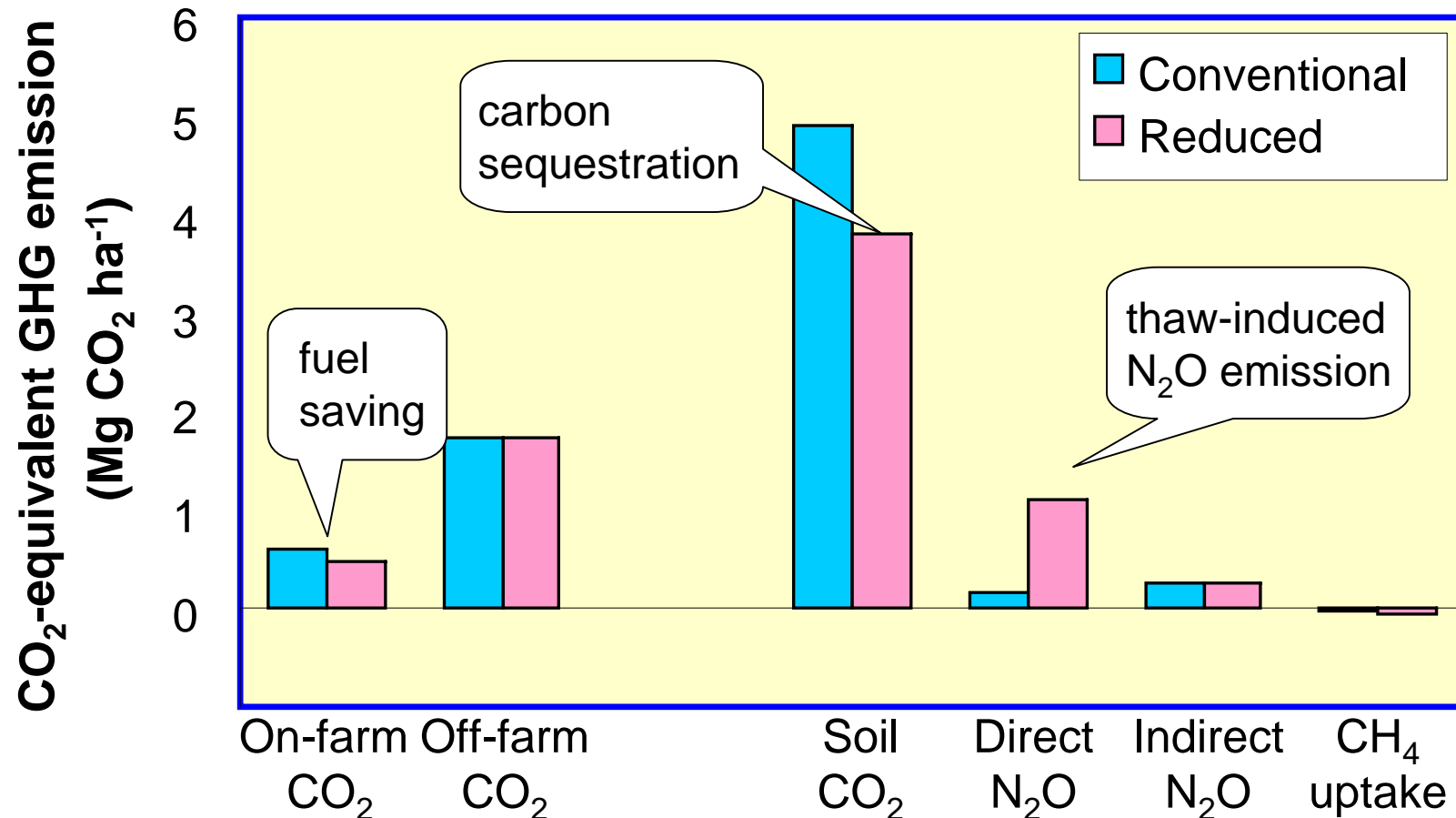


## Implementation of reduced tillage in Tokachi

- 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

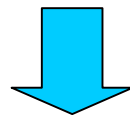
# Conclusion: Trade-off assessment



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 !