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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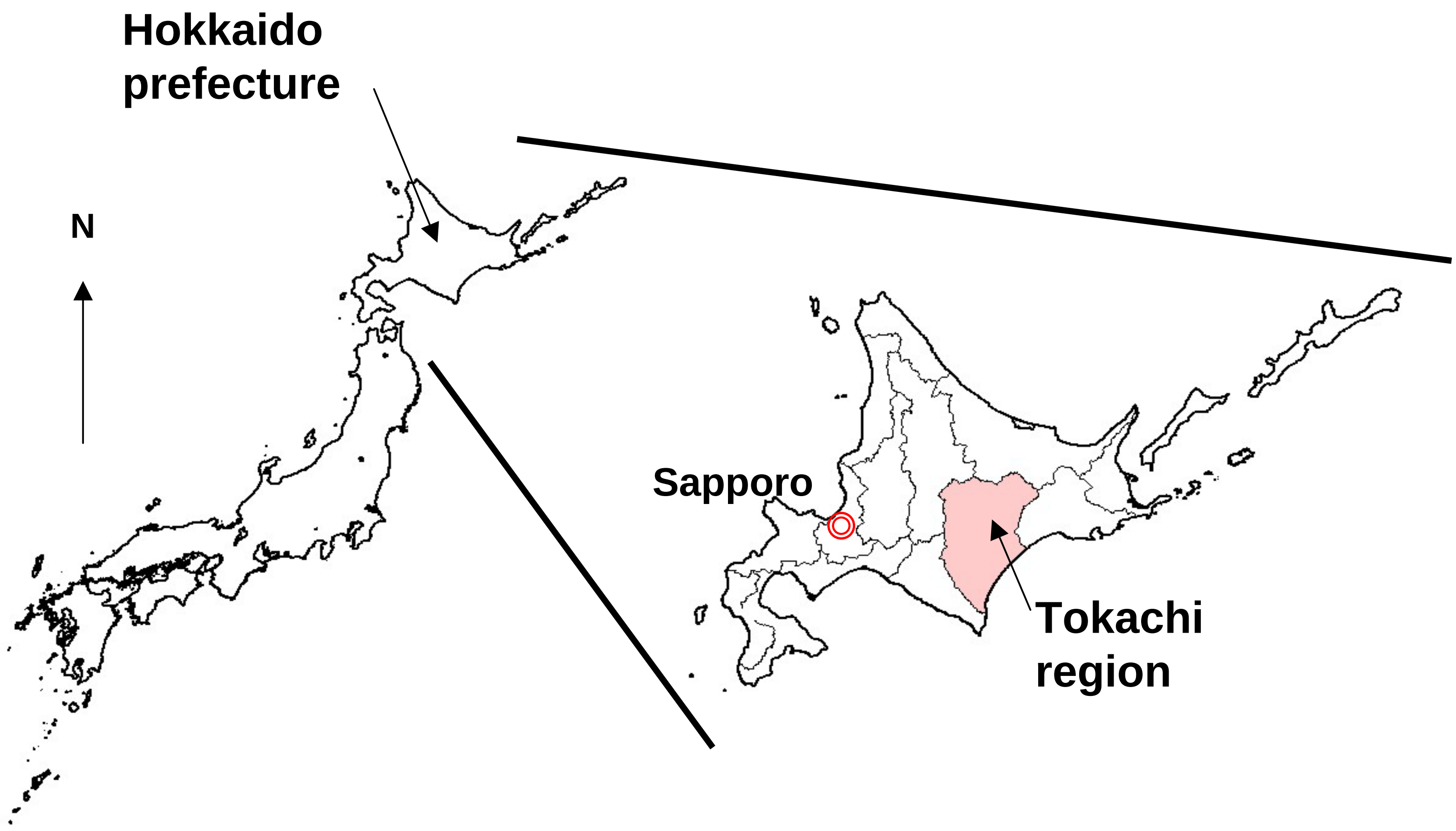
Background 1: Agriculture in the Tokachi region of Hokkaido



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)



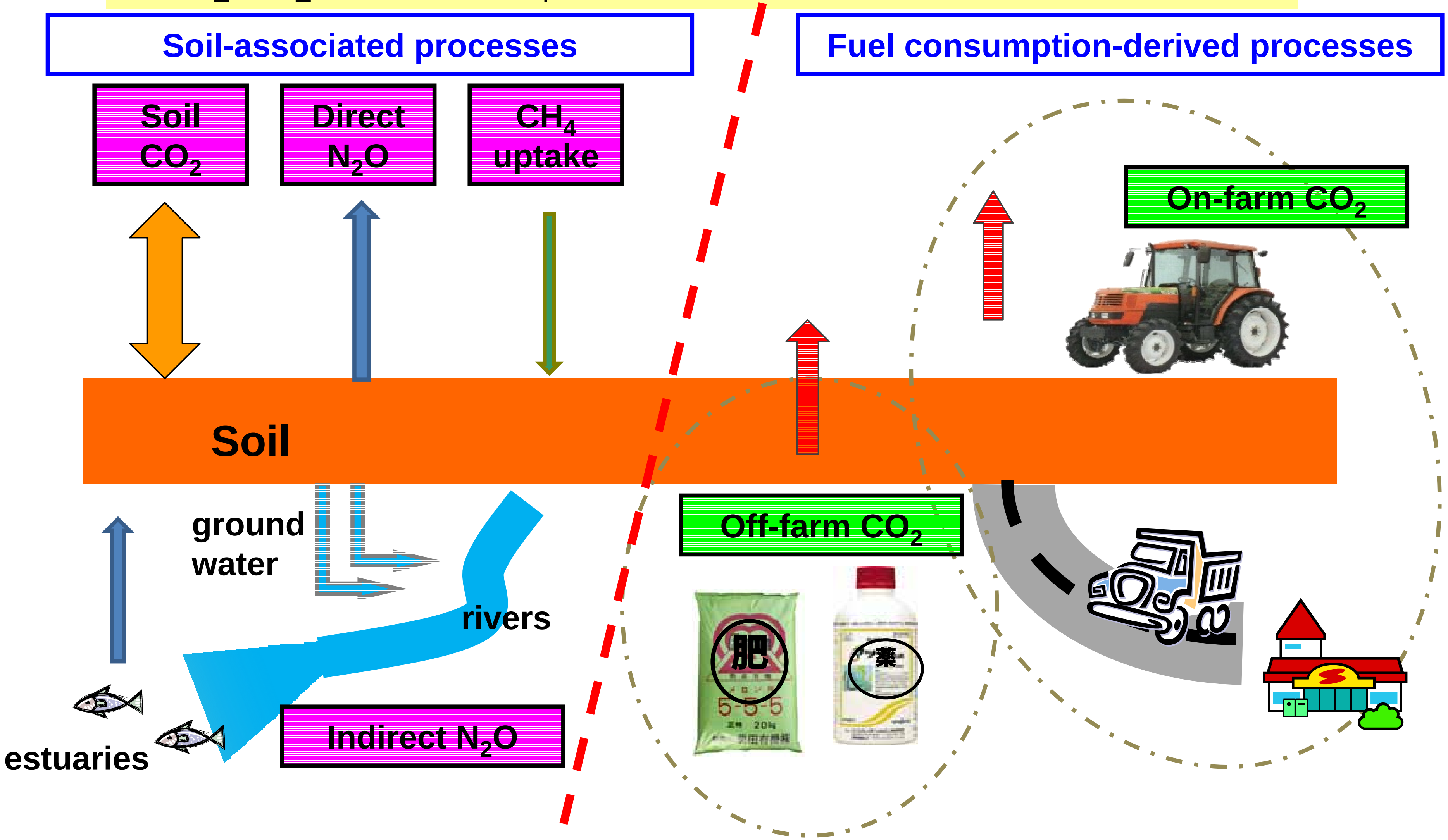


➢ Intensive (deep and frequent) soil tillage


➢ Material-intensive (Chemical fertilizer and biocides use)

Background 4:
GHG from crop production

In the cropping system, significant greenhouse gas (CO_2, N_2O and CH_4) emissions may occur.



Result :
Annual CO_2-equivalent GHG emissions

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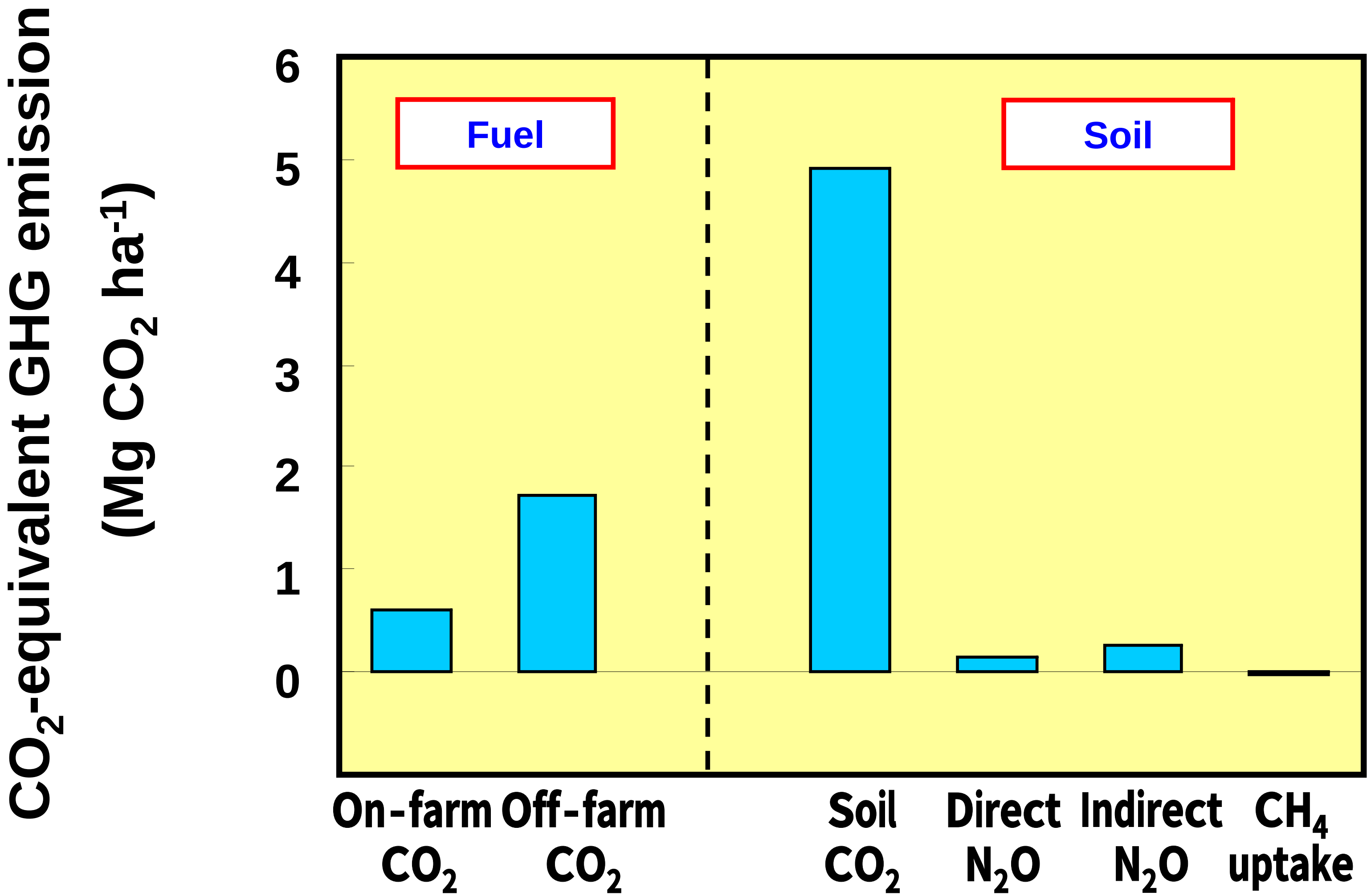
■ GHG emissions from conventional sugar beet production



Possible mitigation options

Conservation tillage

(+) Reduced fuel consumption and CO_2 emissions

(+) Soil carbon sequestration

(-) Weed problem

Manure application

(+) Soil carbon sequestration

(-) Increased fuel consumption for transporting and spreading

(-) Increased N_2O emissions

(+) positive impacts
(-) negative impacts

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

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Implementation of reduced tillage in Tokachi

- Significant reductions in CO_2 from fuels (+)
- Higher soil C sequestration (+)
  (lower soil organic matter decomposition rates)
- In sugar beet, increased annual N_2O emissions due to large N_2O 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

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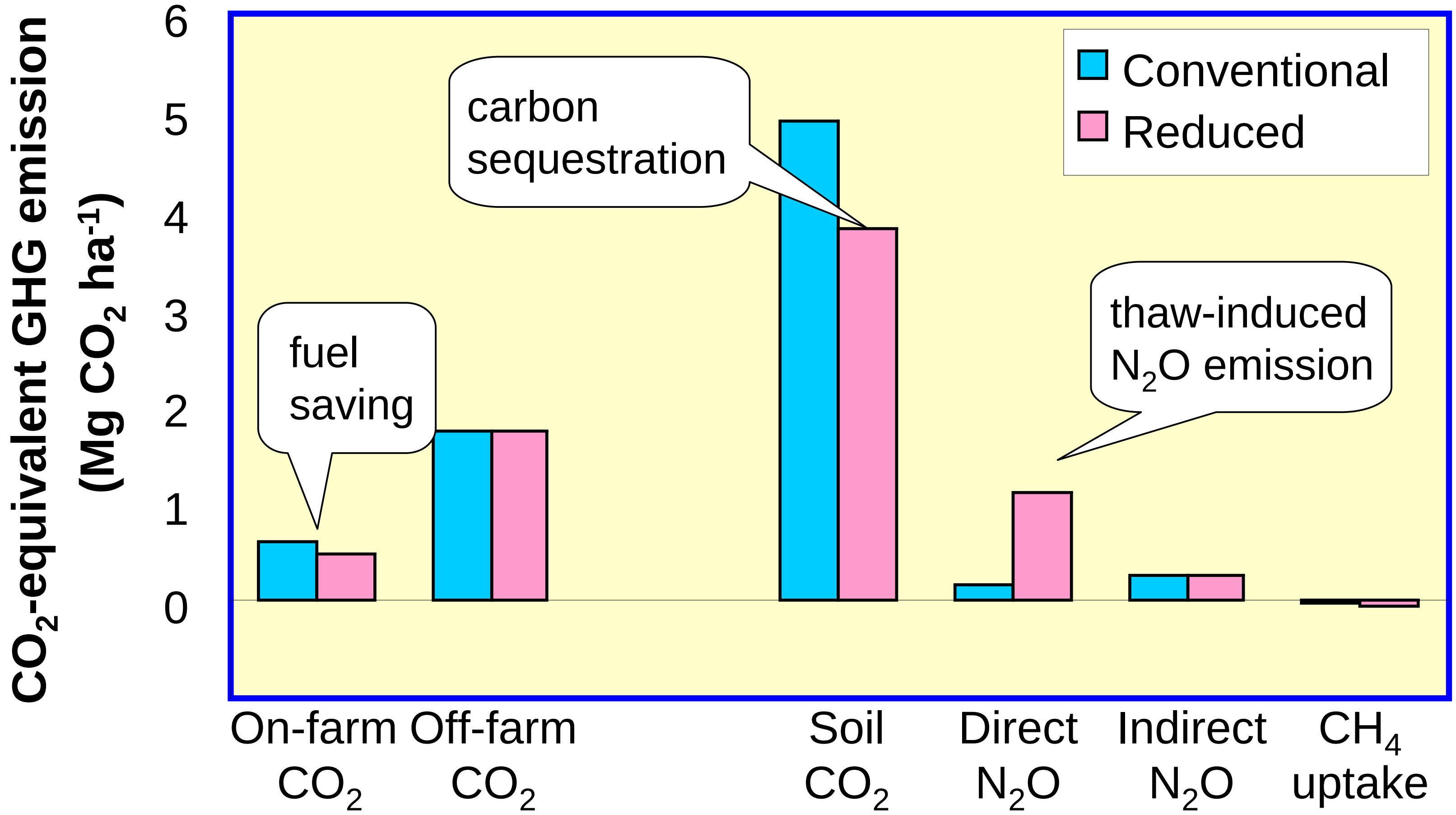
Implementation of reduced tillage in Tokachi



➢ 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_2, N_2O and CH_4

- 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

Thank you for your attention !