



The Development of the Indicator of Risk of Water Contamination by Nitrate in Canadian Agricultural Soils



C.F. Drury, J.Y. Yang, R. De Jong, X.M. Yang, and K. Reid



Agriculture & Agri-Food Canada
Harrow, Ontario



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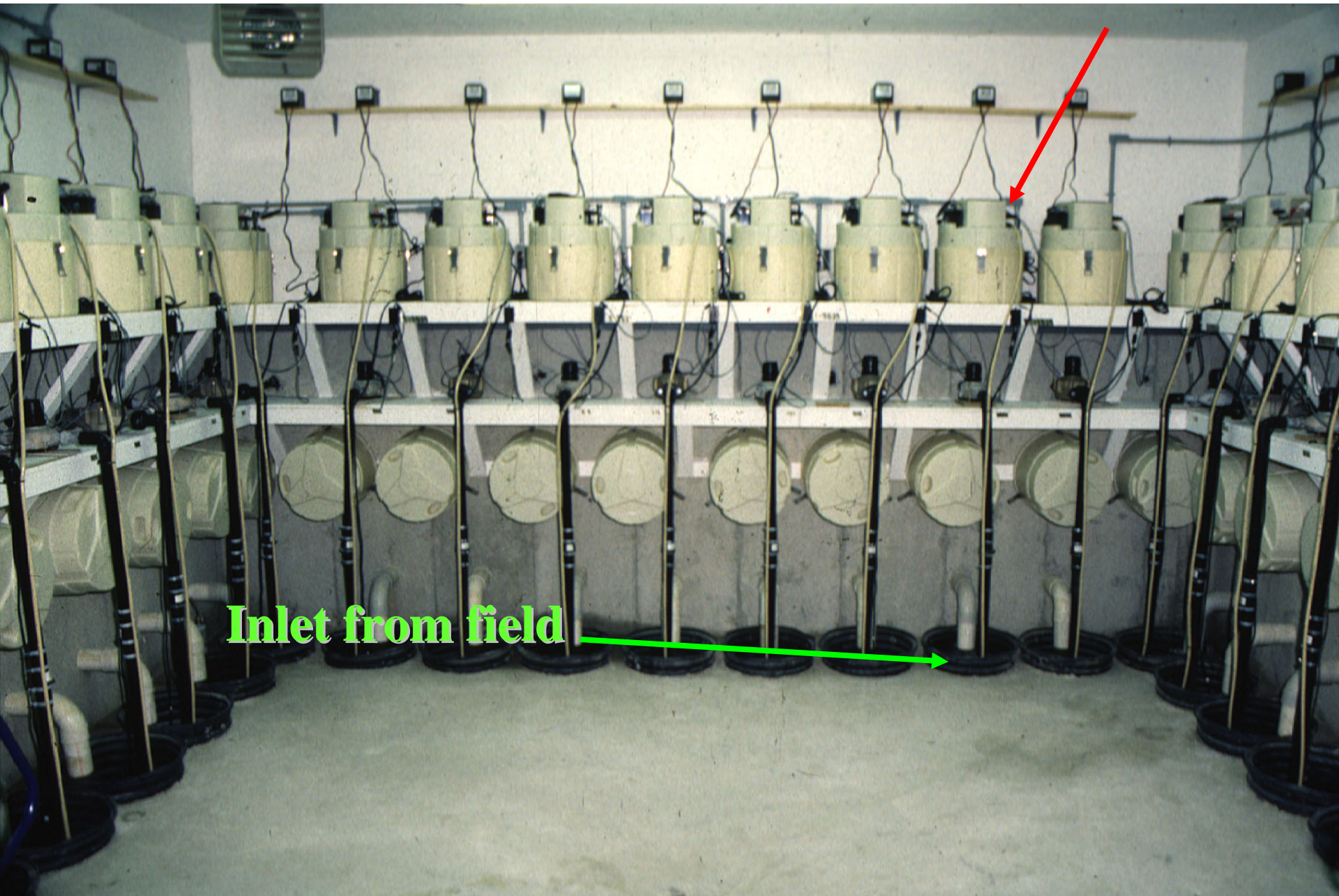
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Factors Affecting Nitrate Loss from Agricultural Soils

- ➔ Soil water content, precipitation intensity, frequency & quantity
- ➔ Soil nitrate levels (fertilizers, manures & legumes)
- ➔ Crop utilization
- ➔ Soil type
- ➔ Tile drainage
- ➔ Landscape

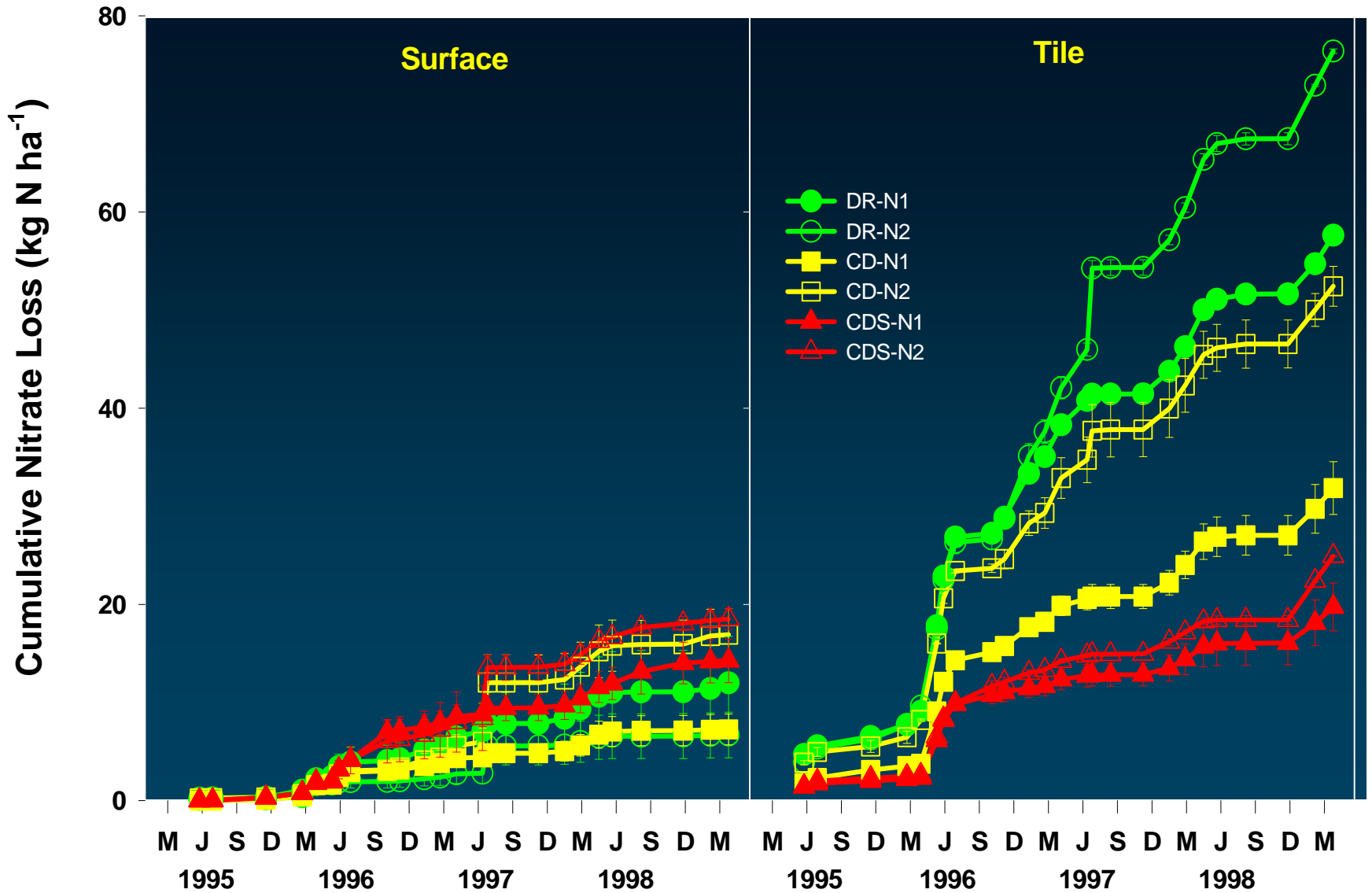


Autosampler

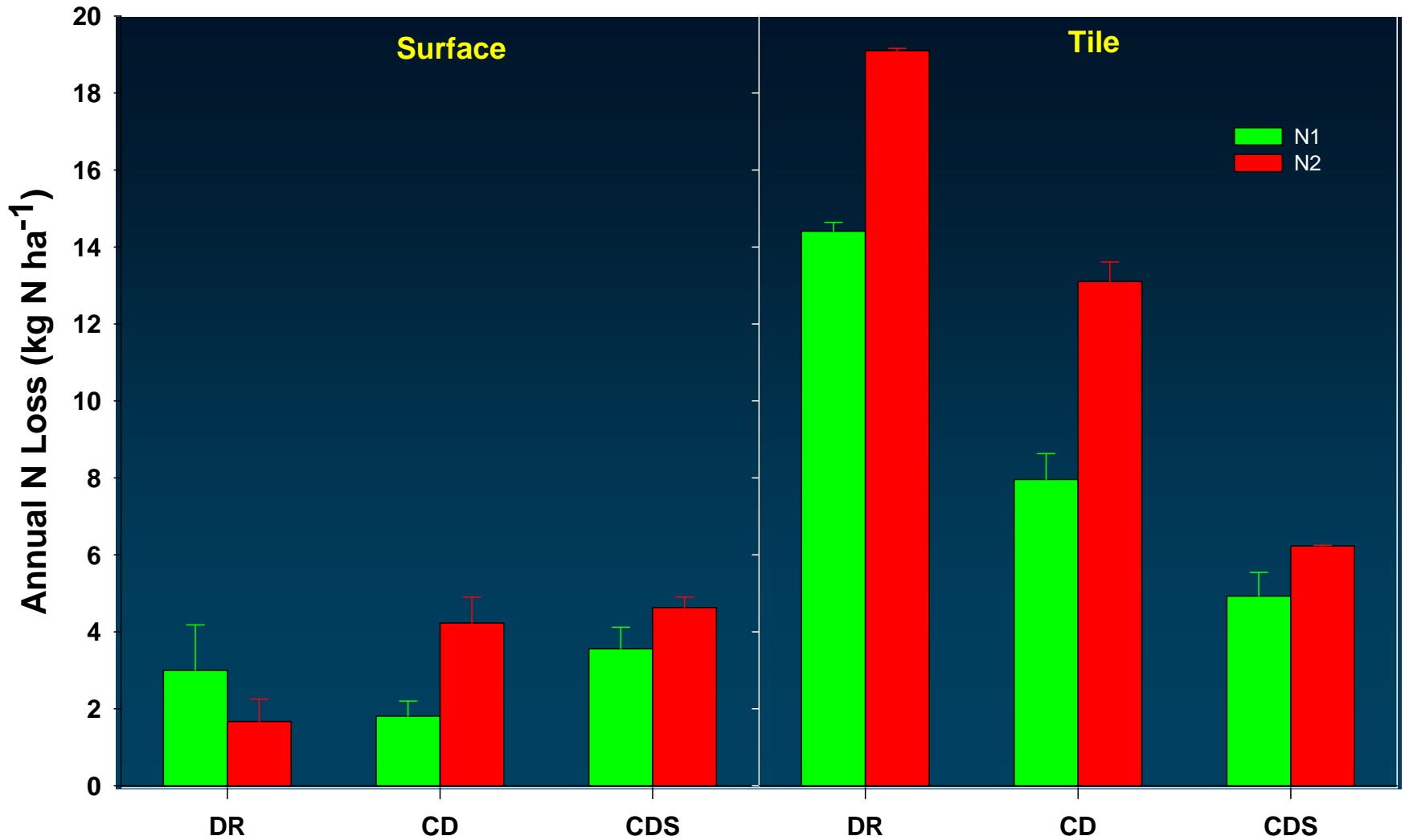


Inlet from field

Surface Runoff and Tile Drainage Nitrate Loss



Annual Surface Runoff and Tile Drainage Nitrate Loss

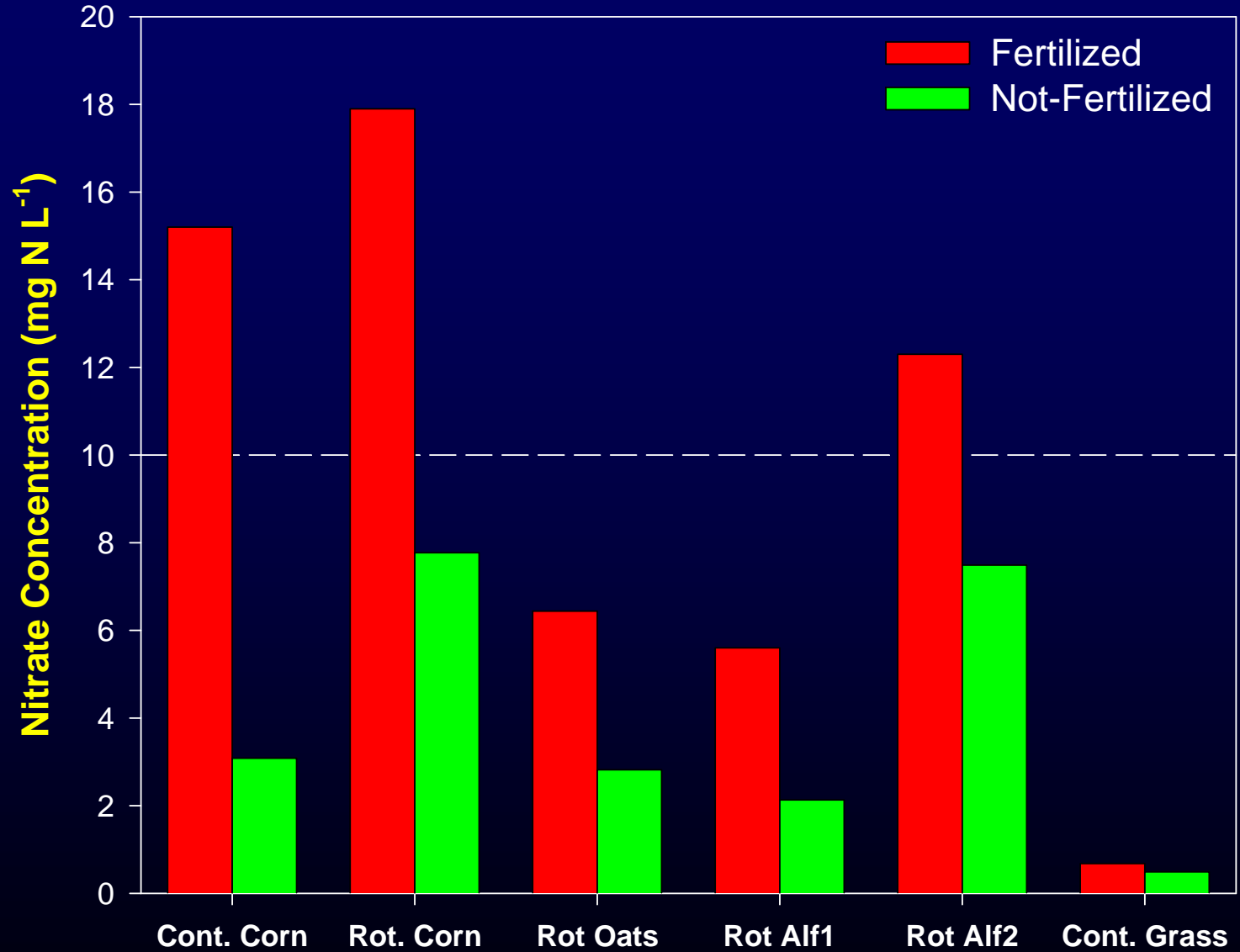


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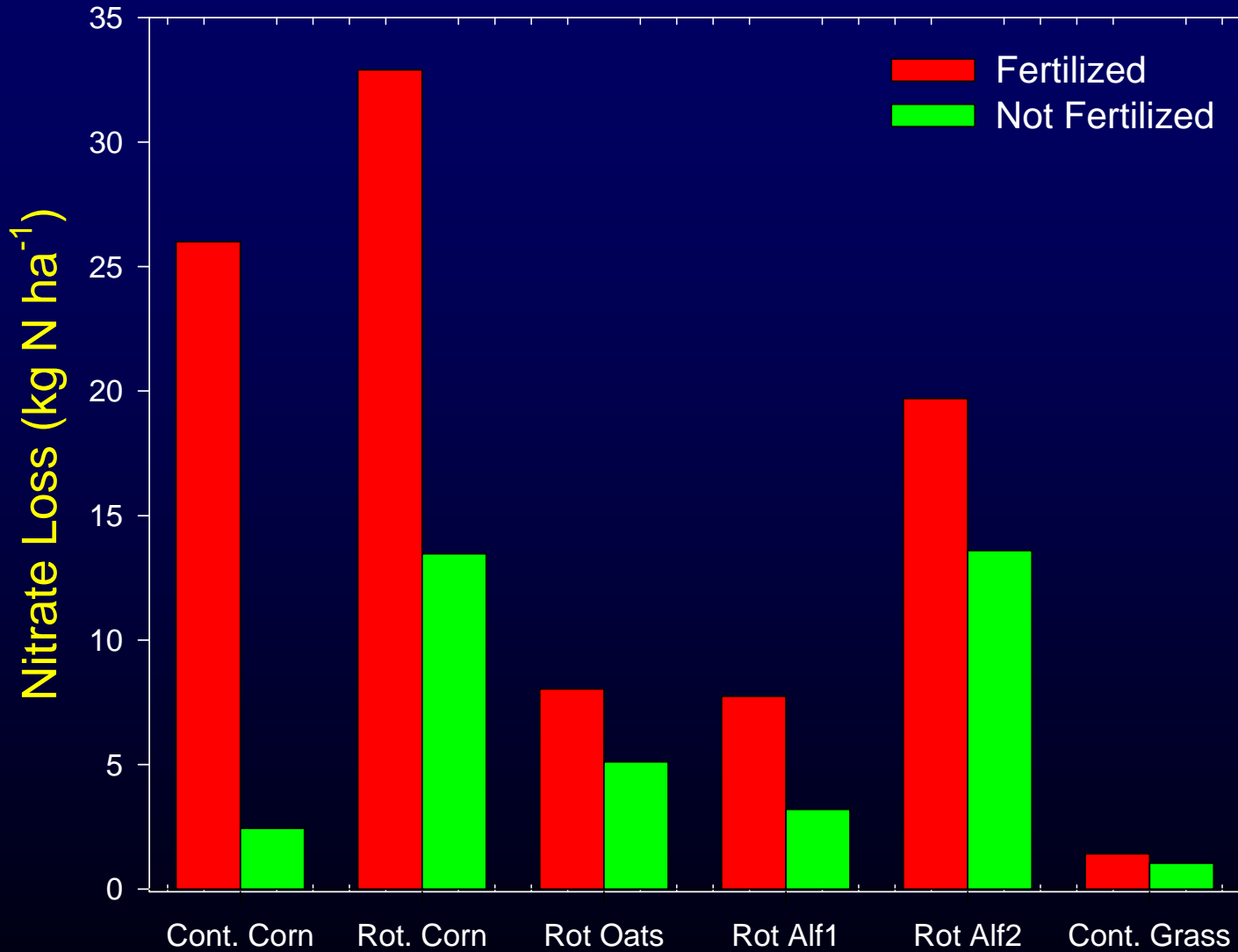
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Nitrate Concentration in Tile Drainage Water



Annual Nitrate Loss in Tile Drainage Water



Objectives

- Evaluate N leaching in 5 dominant soil types in Ontario which represent hydrologic soil groups A, B, C (2 soils) and D.
- Evaluate the impact of tile drainage on nitrate and chloride loss from the Brookston clay loam (HSG-D) and Perth clay loam (HSG-C) soils.

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Field study (cont'd)

➤ **Treatments (4)**

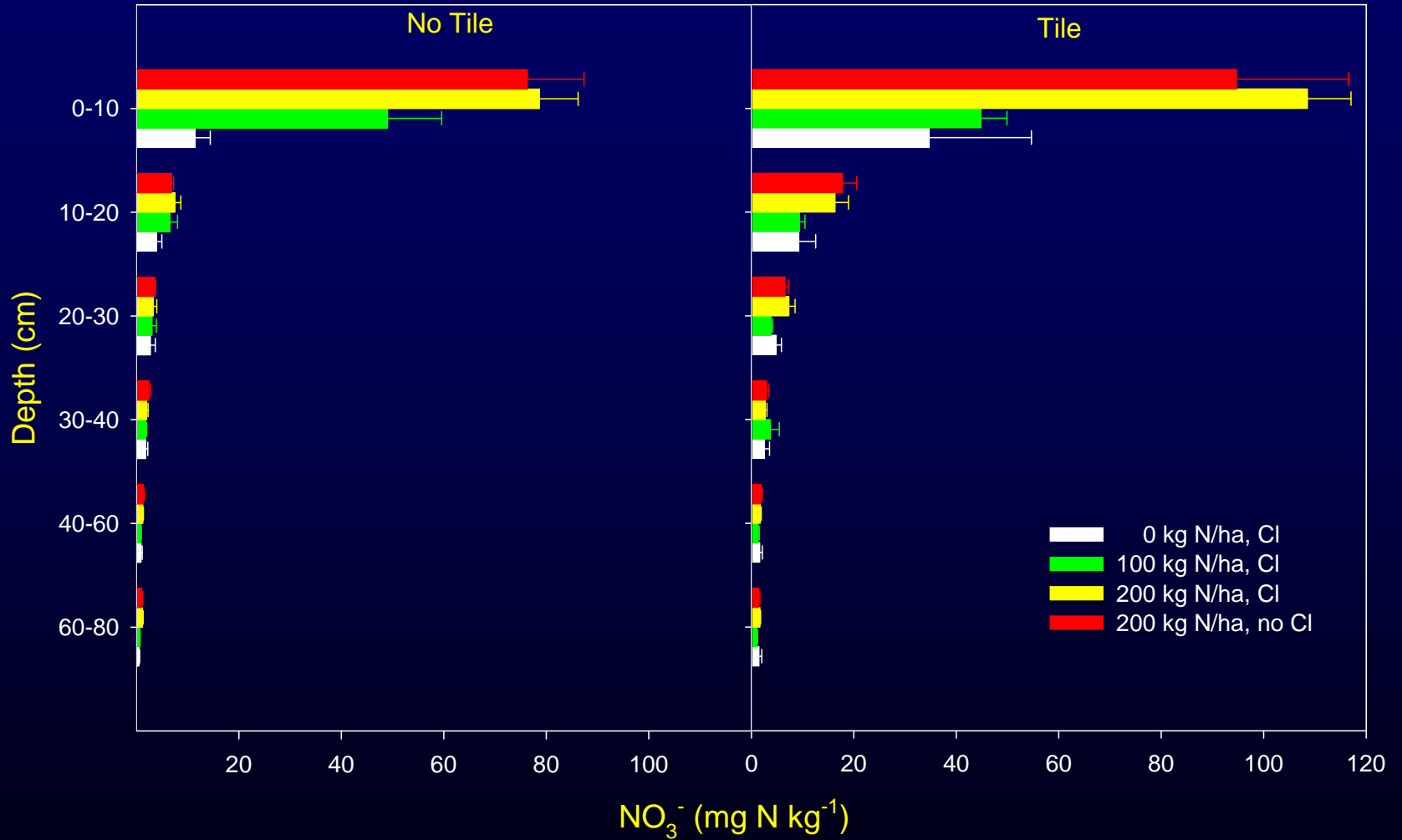
- ✓ 0 kg N/ha + 1000 kg KCl/ha
- ✓ 100 kg N/ha + 1000 kg KCl/ha
- ✓ 200 kg N/ha + 1000 kg KCl/ha
- ✓ 200 kg N/ha + 0 kg KCl/ha

➤ **Replicates (4)**

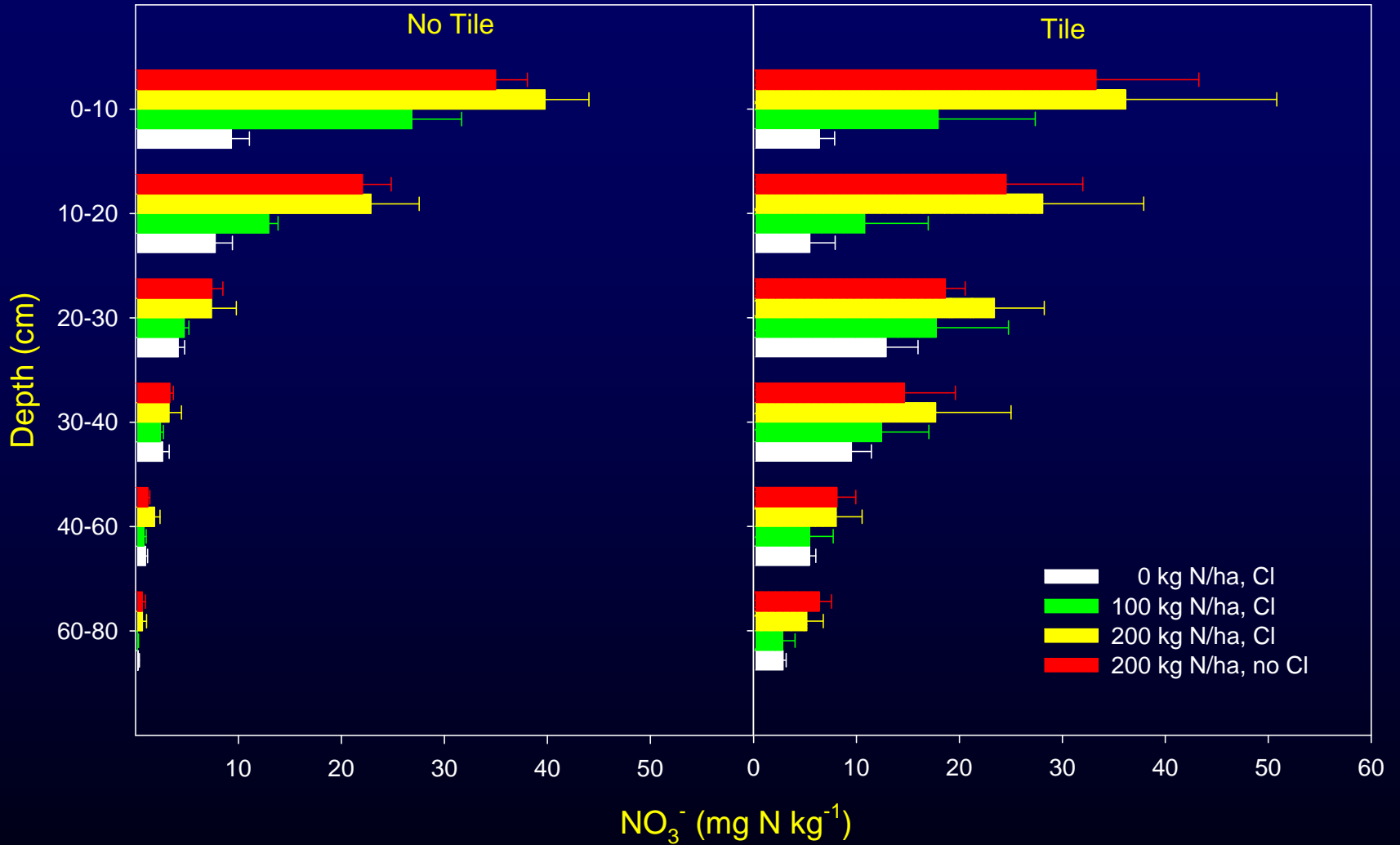
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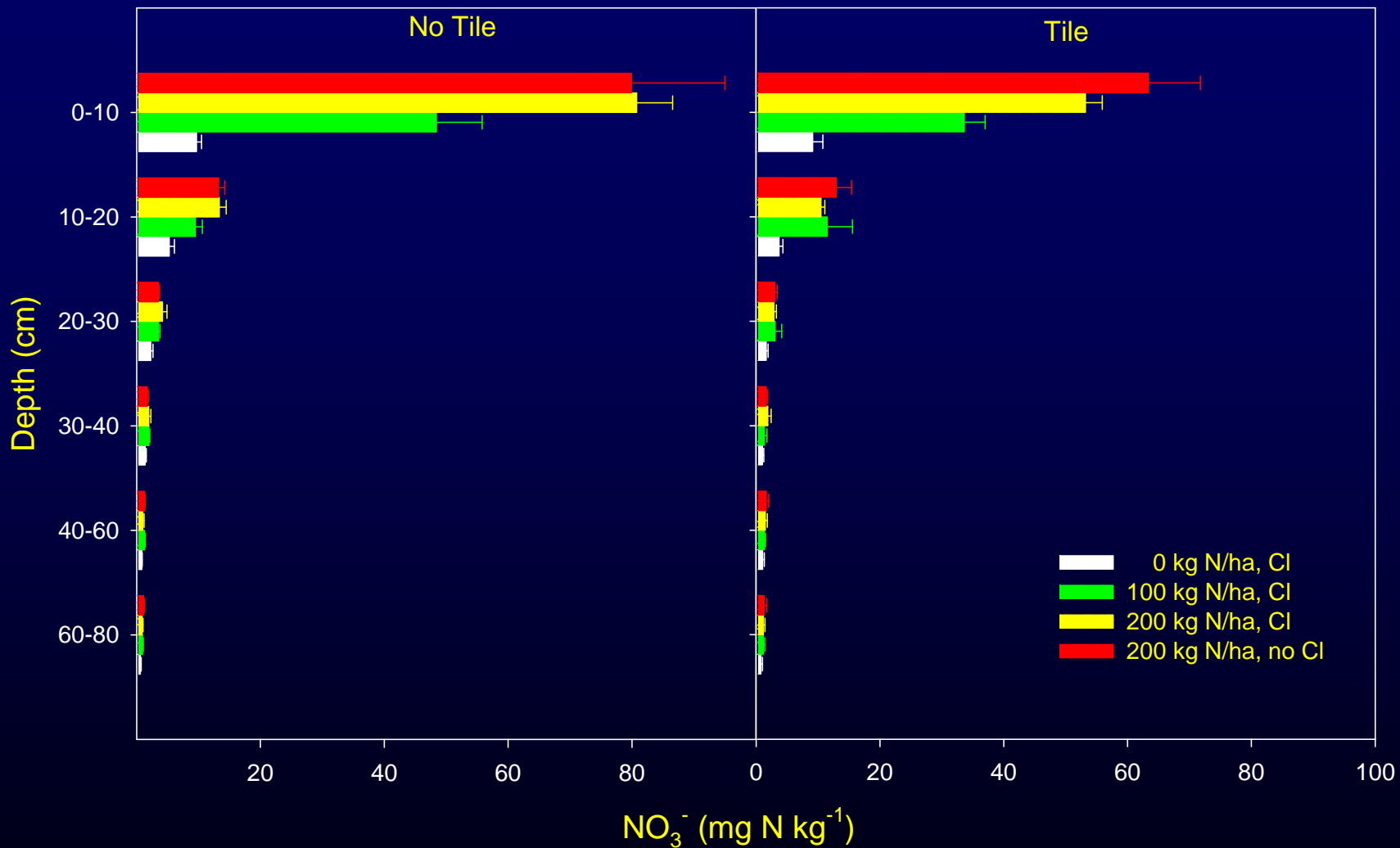
Brookston Clay Loam (2 weeks after application)



Brookston Clay Loam (8 weeks after application)

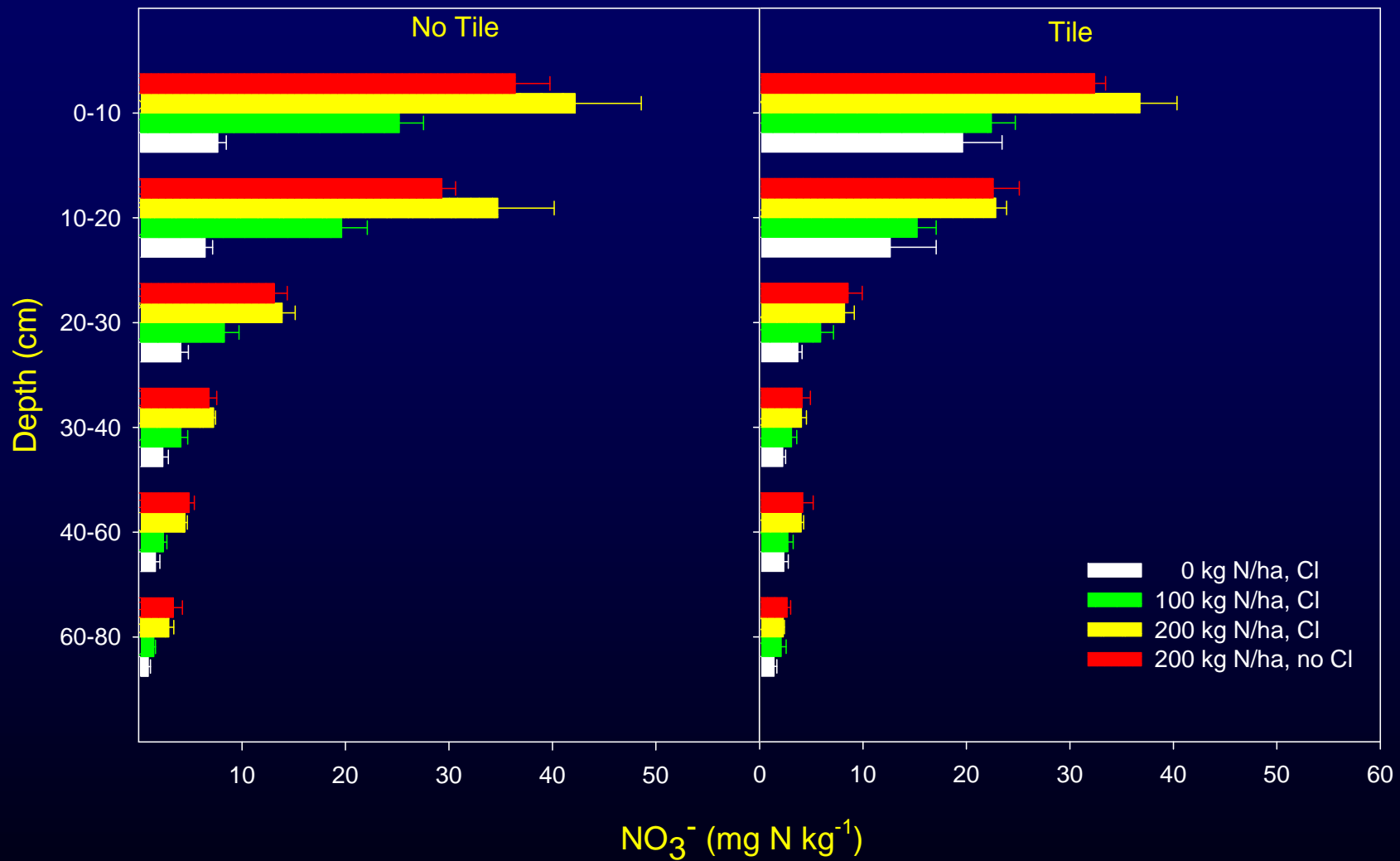


Perth Clay Loam (2 weeks after application)





Perth Clay Loam (8 weeks after application)



RSN and IROWC-N Indicators

■ **Residual Soil Nitrogen (RSN):**

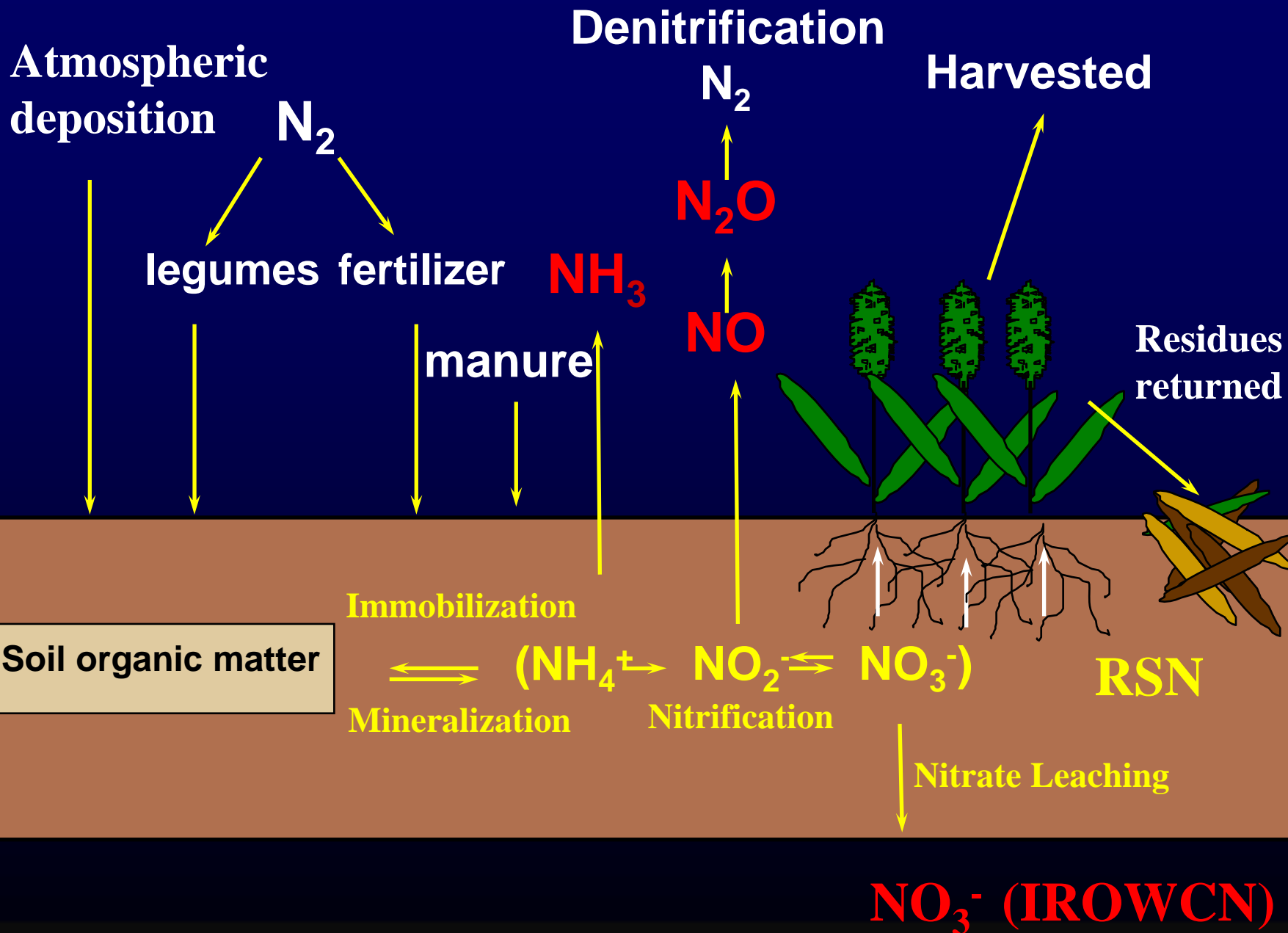
Residual Soil Nitrogen – amount of N which remains in the soil at the end of the growing season.

■ **Indicator of Water Contamination by N (IROWC-N):**

Indicator of Risk of Water Contamination by Nitrogen - Nitrate concentration in water & loss from the effective rooting depth of the soil.

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RSN budget (kg N ha⁻¹)

RSN = N inputs – N outputs

N inputs:

Fertilizer

Manure (Yr 1 inorganic N, yrs 2-4 org. N mineralization)

N-fixation by legumes (soybean, alfalfa, red clover)

Atmospheric deposition

N Outputs:

Crop uptake and removal from field

Ammonium volatilization

Denitrification (N₂O + N₂)

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Farmland in the Very High Risk Category - RSN

1981

1986

1991

1996

2001

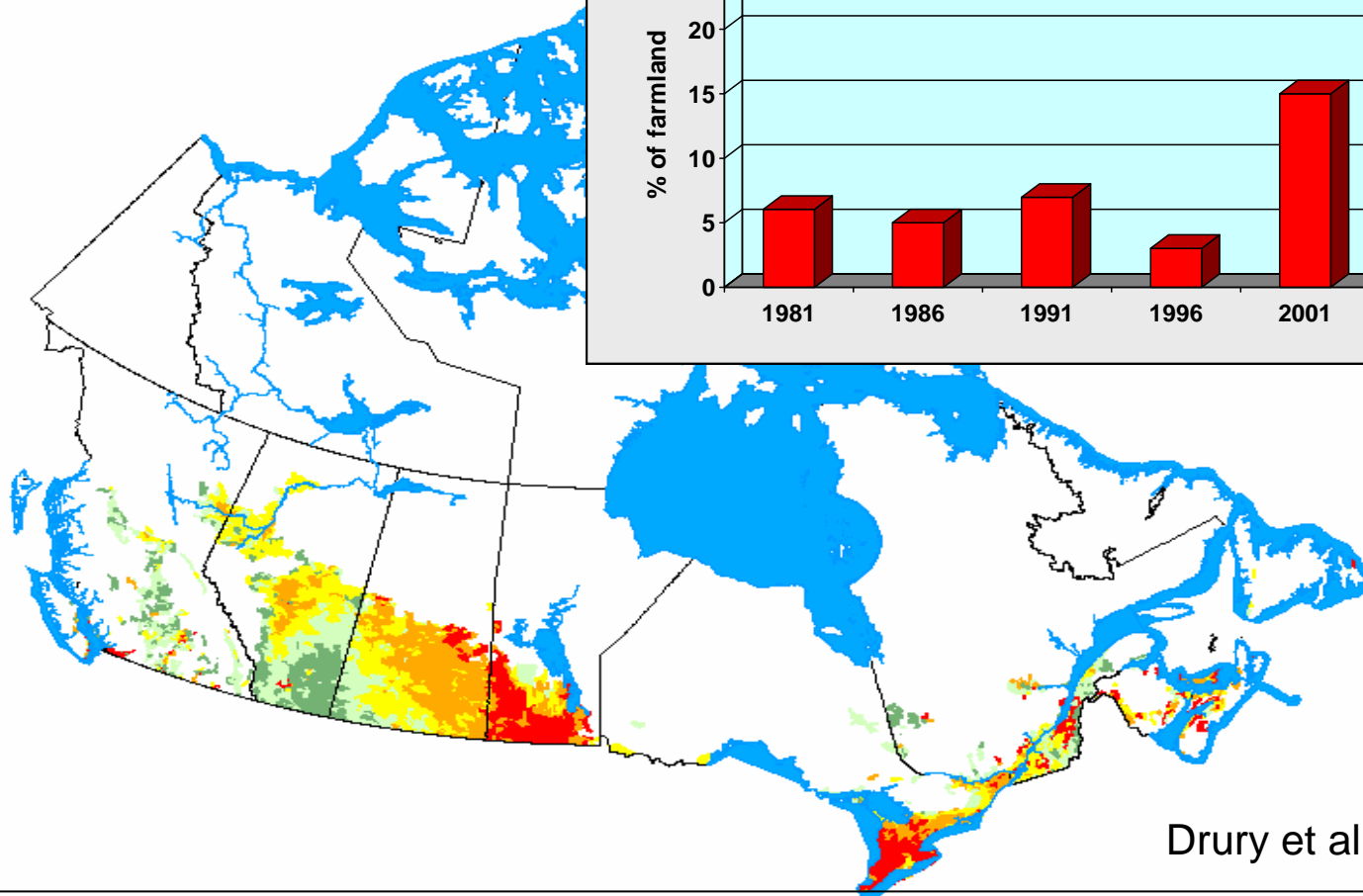
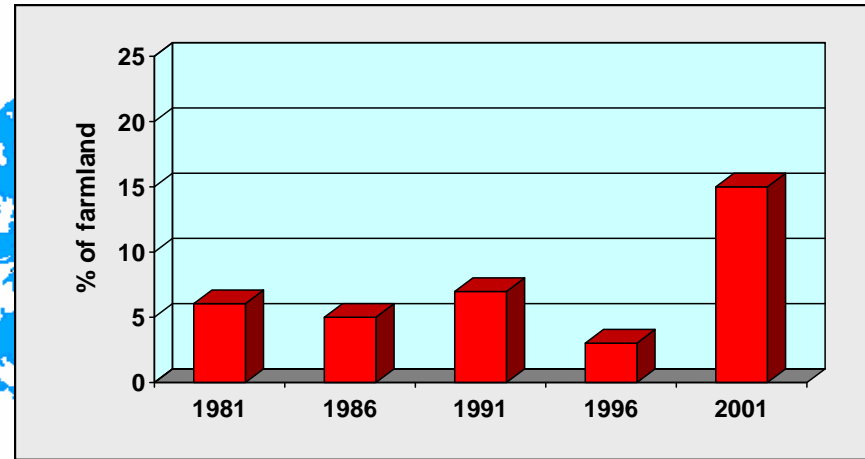
6%

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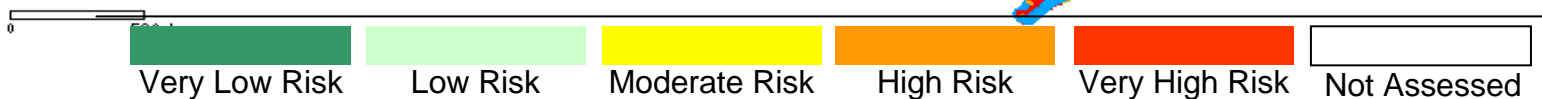
7%

3%

15%



Drury et al. 2007



RSN Verification Project

Sampling Strategy Fall 2005 & Spring 2006

Hypothetical Farm with 3 Fields (crops)

Sampling Protocol:

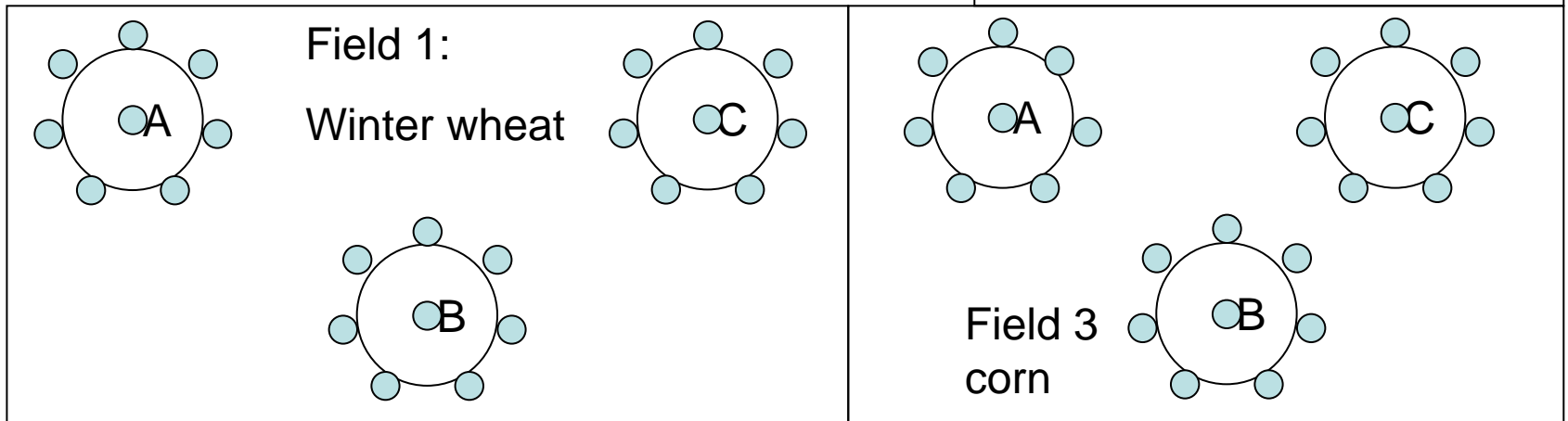
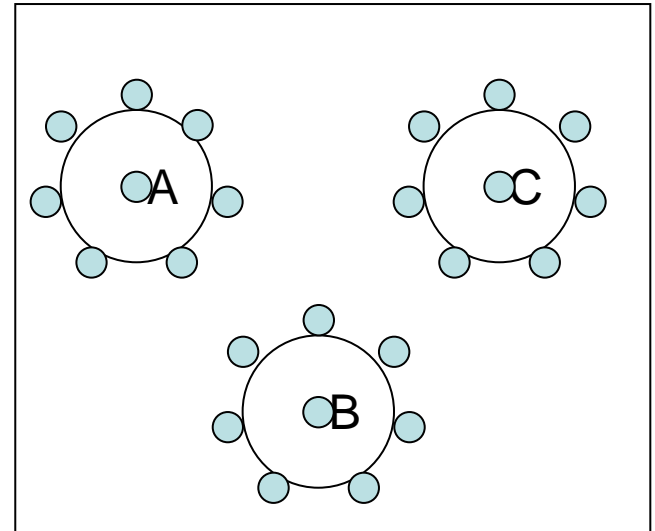
3 Locations were sampled per field (ex A, B, C)

3 Depths were sampled per location

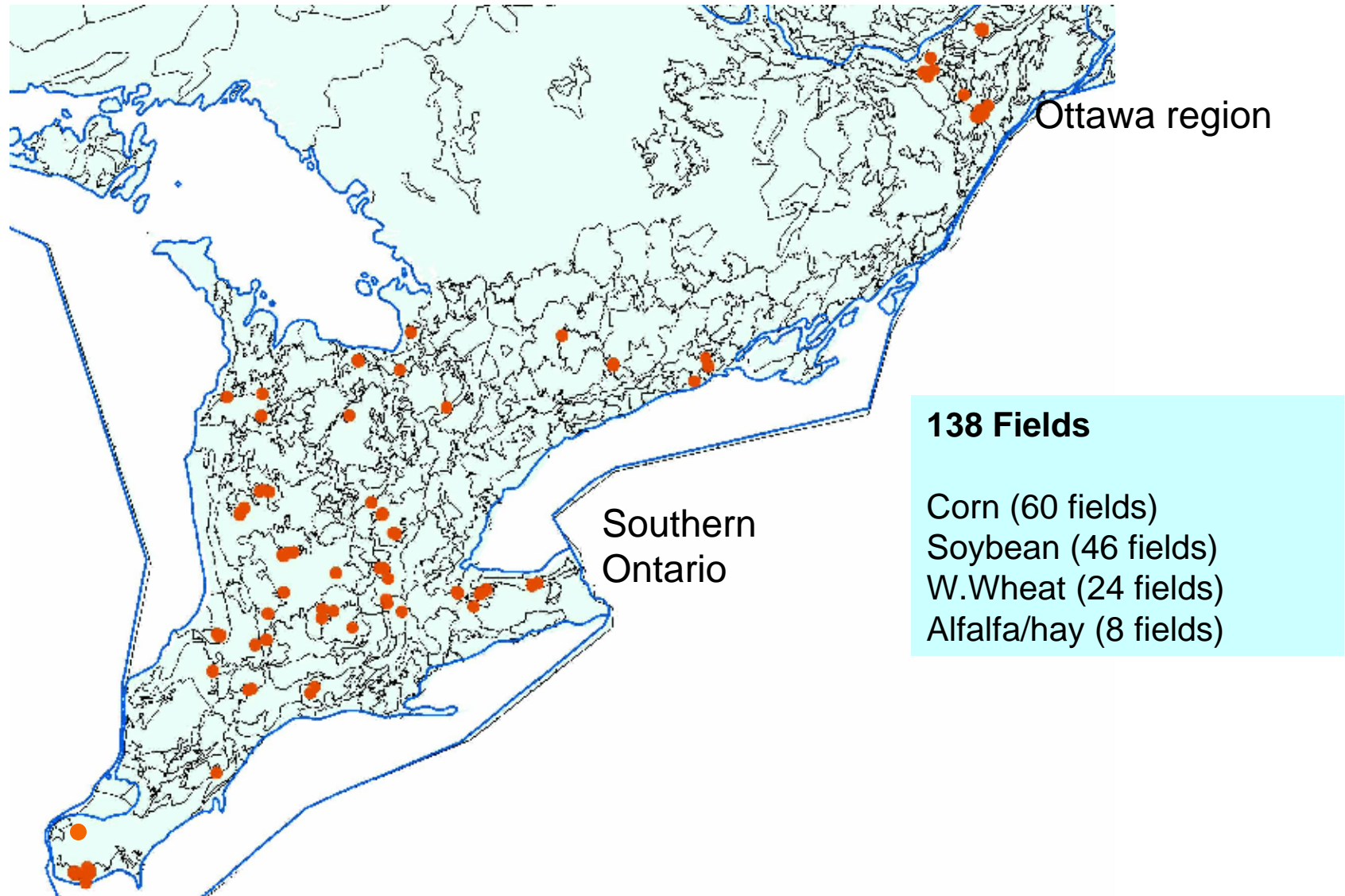
0 to 15 cm (8 composite samples)

15 to 30 cm (8 composite samples)

30 to 60 cm (4 composite samples)



RSN Verification Project - Fall 2005



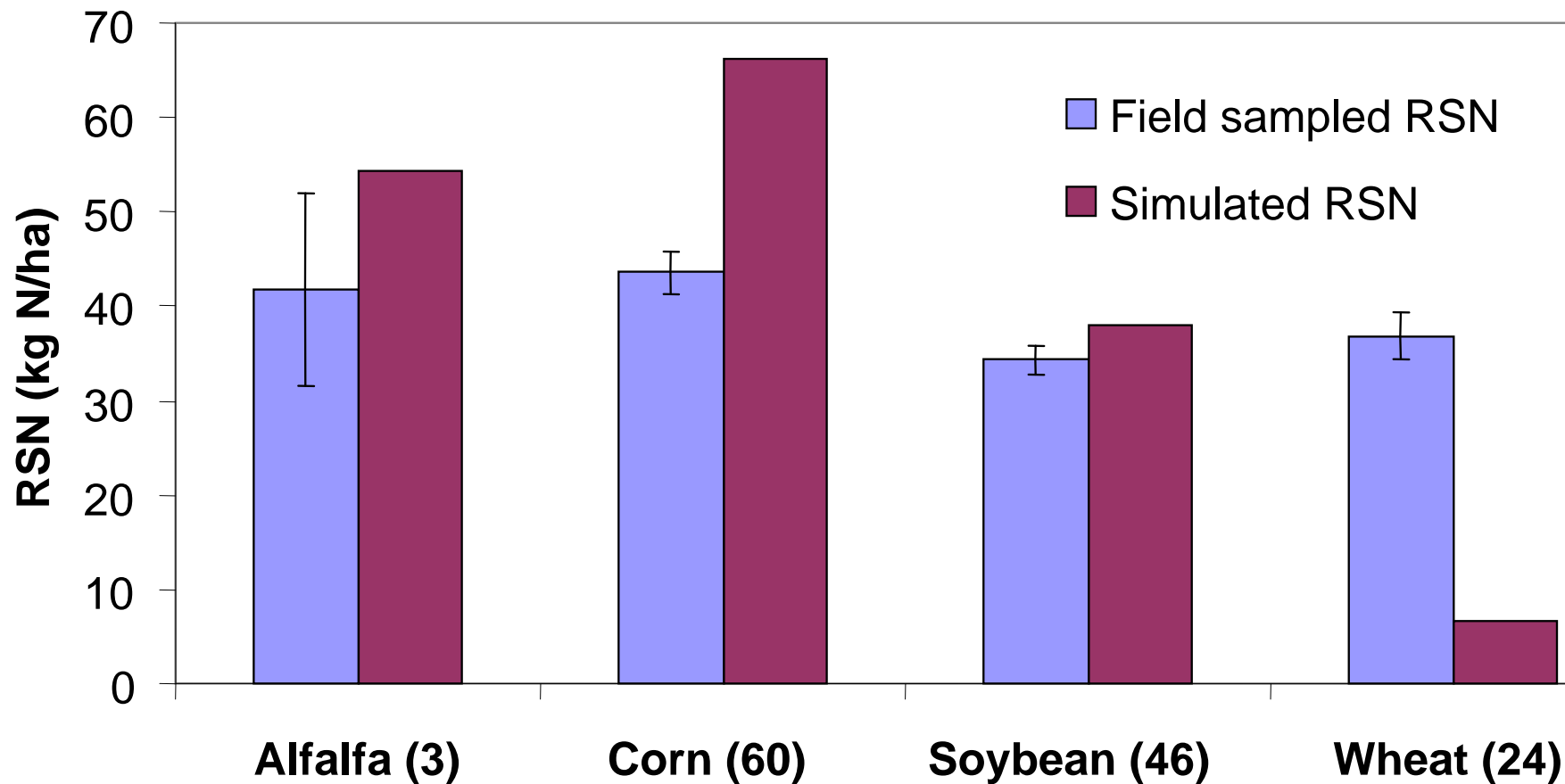
RSN – Measured vs Predicted

- RSN Fall 2005 (138 farms) = 38.0 kg N/ha
- Predicted Fall 2005 (138 farms) = 40.6 kg N/ha

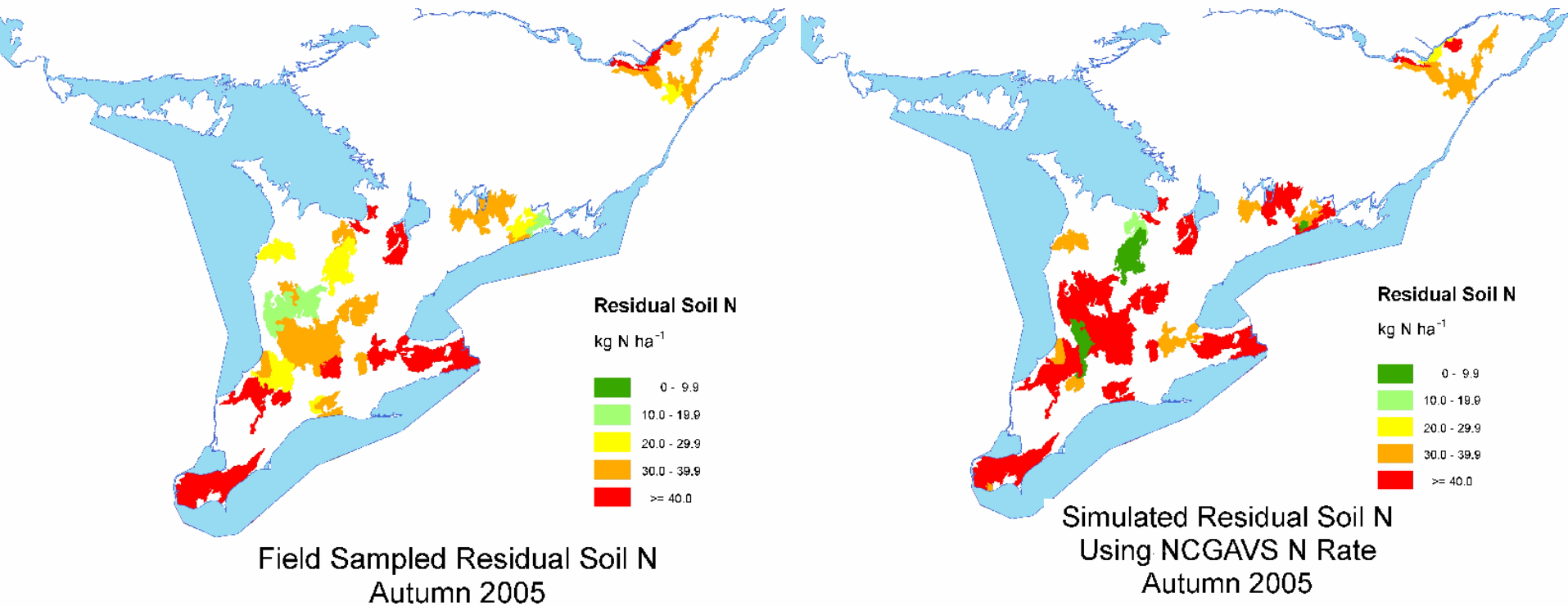
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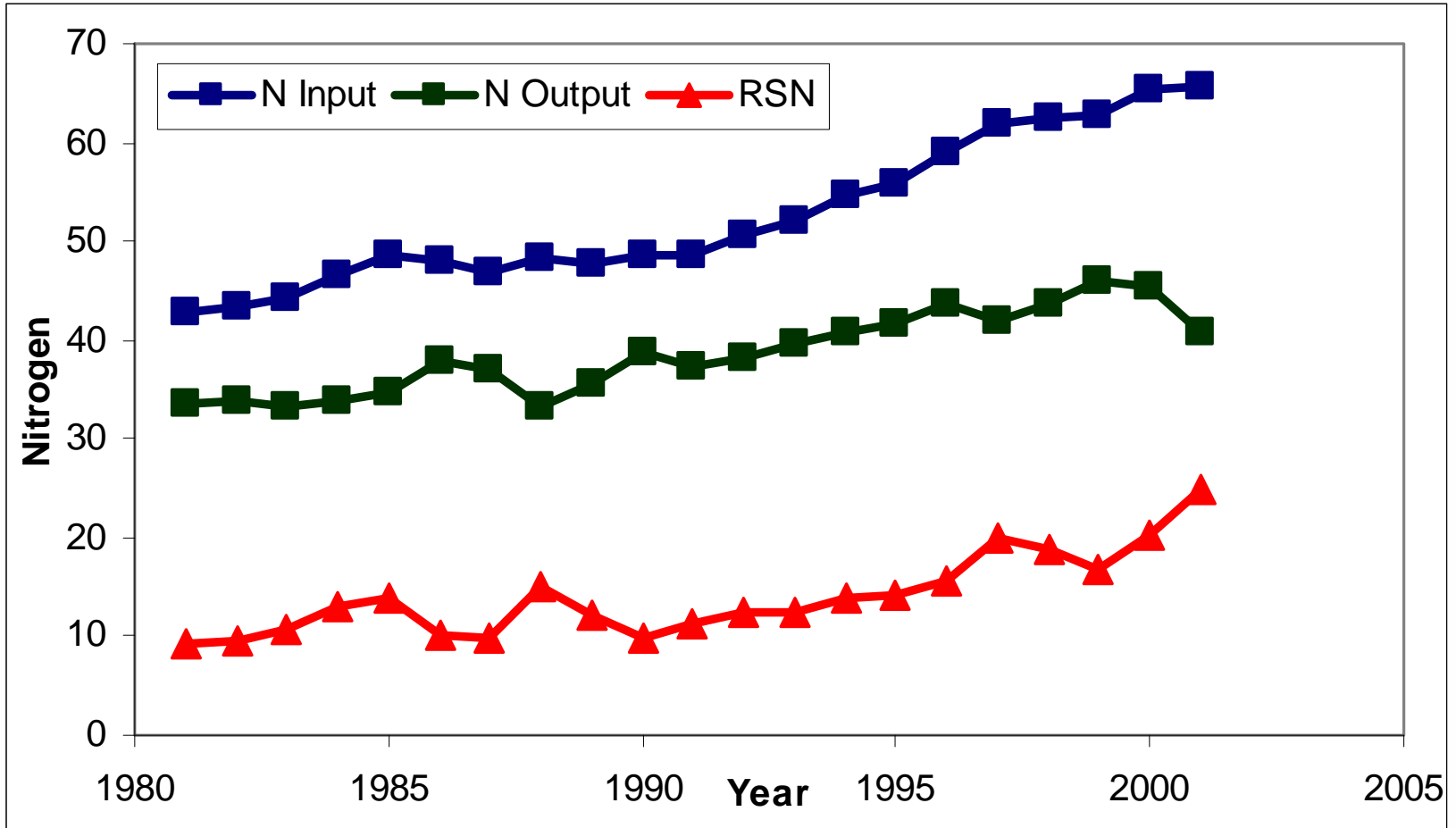
Measured vs Simulated RSN (Ontario, 2005)



Measured vs Simulated RSN



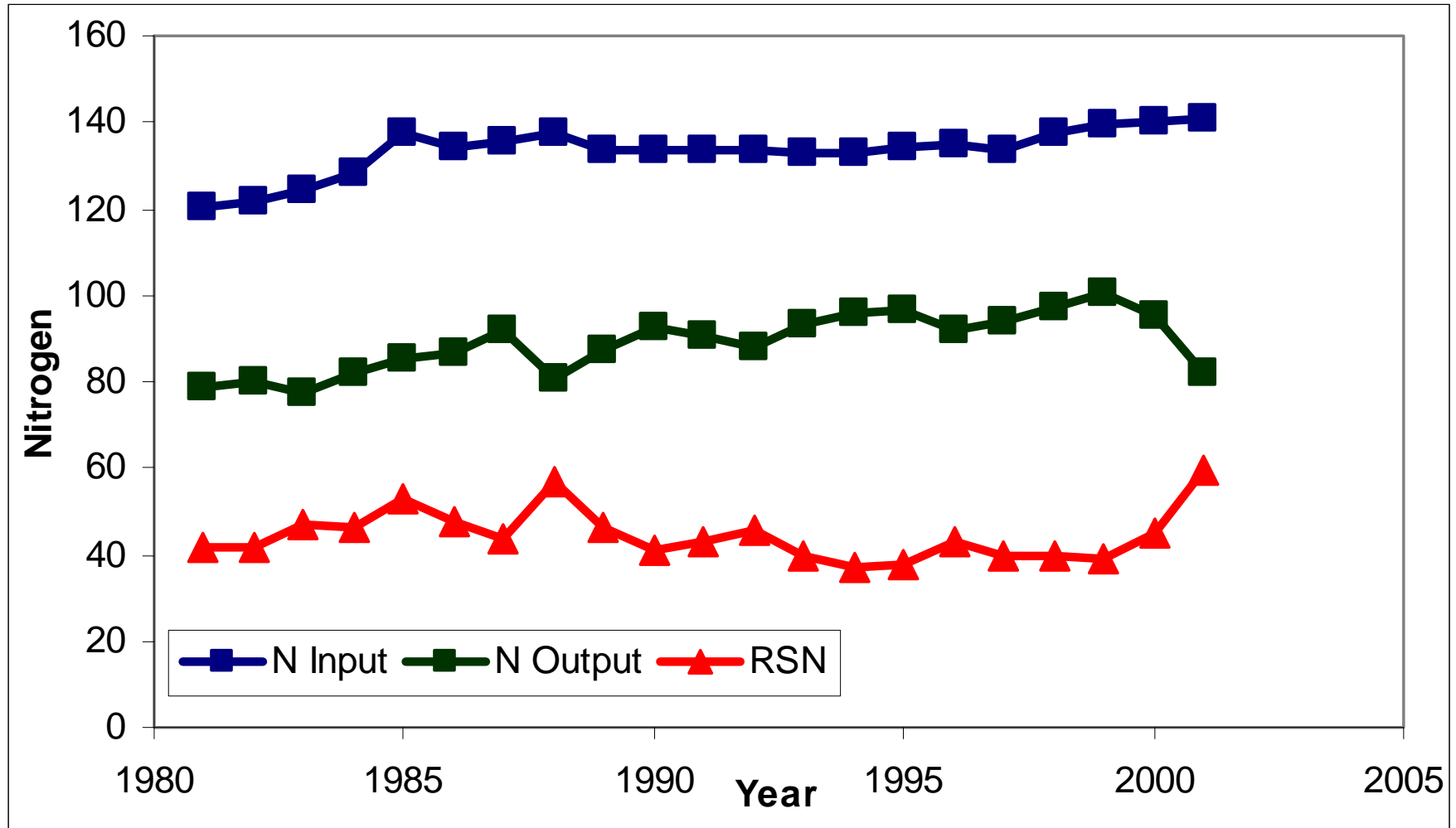
Canada – Residual Soil N



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Ontario – Residual Soil N



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Indicator of the Risk of Water Contamination by Nitrogen (IROWC-N)

IROWC-N is a simple nitrogen balance which estimates the amount of nitrogen that remains in the soil at the end of the growing season (RSN):

$$\mathbf{RSN = (N_{input} - N_{output}) / FARMLAND}$$

RSN = Residual Soil Nitrogen

N_{input} = N_{fertilizer} + N_{manure} + N_{fixation} + N_{deposition}

N_{output} = N_{crop} + N_{denitrification} + N_{volatilization}

FARMLAND = Area of crop + Area of pasture



Indicator of the Risk of Water Contamination by Nitrogen (IROWC-N)

and then estimates the likelihood of N being moved into surface and groundwater by calculating the amount of excess water available to move it:

$$N_{\text{lost}} = \text{RSN} \times (\text{P} - \text{PE}) / (\text{AWHC} + (\text{P} - \text{PE}))$$

RSN = Residual Soil Nitrogen

P = Precipitation

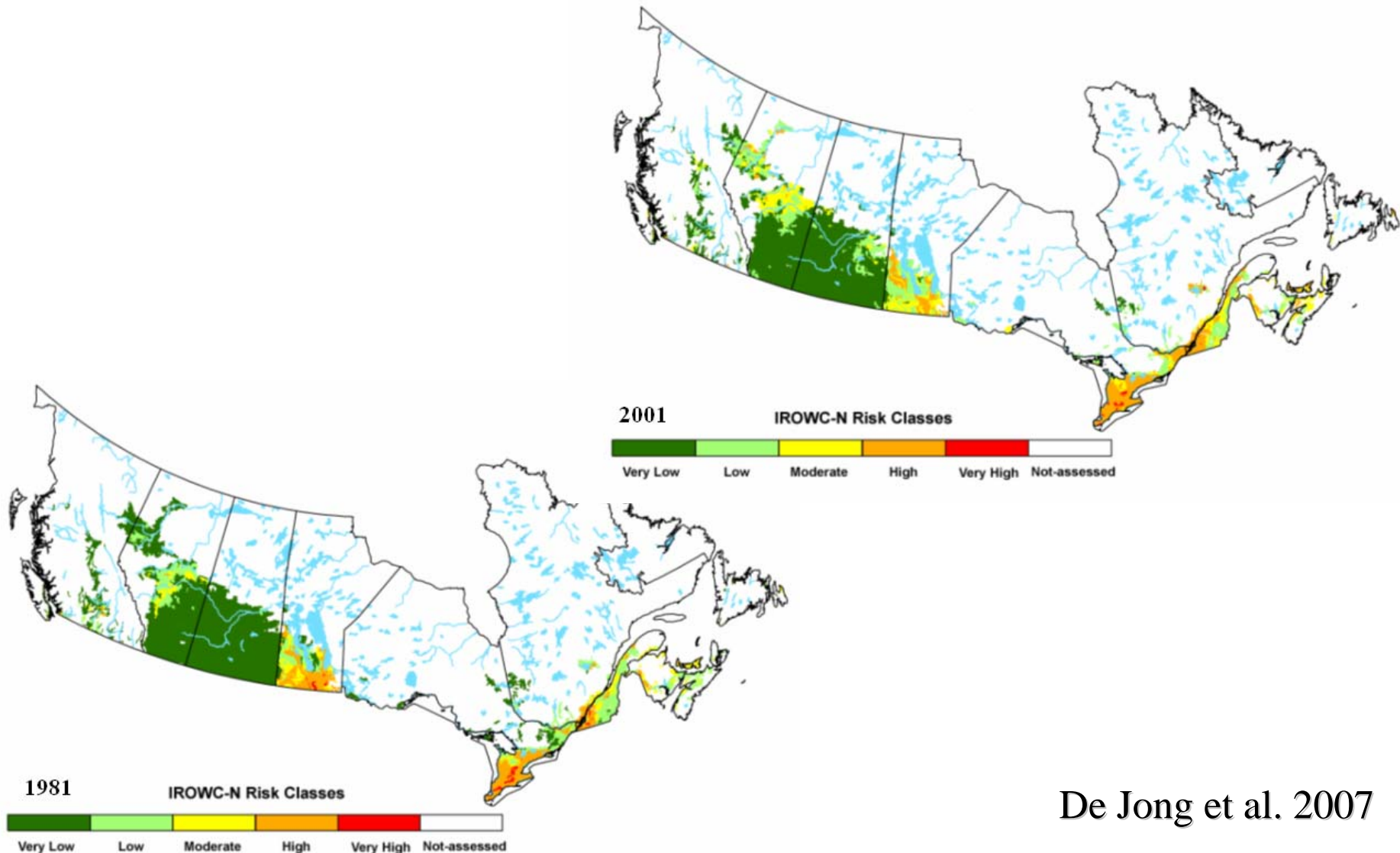
PE = Potential Evapotranspiration

AWHC = Available Water Holding Capacity

$$\text{Nconc} = \text{Nlost} \times 100 / (\text{P} - \text{PE})$$



Indicator of the Risk of Water Contamination by Nitrogen (IROWC-N)



De Jong et al. 2007

Summary

Nitrate loss is affected by:

- Climate
- N Inputs (Fertilizer, manure, legume crops)
- N Outputs (Crop removal, denitrification, NH_3 volatilization)
- Tile Drainage (hydraulic conductivity)
- Soil type
- Soil quality – water storage, hydraulic properties, structure, SOC

Modeling:

- Budget and process models are being developed and validated at the regional, provincial and national scales

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Thank You!

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