# Nitrate leaching measurements using suction cups in field trials

4th NFTN Conference

**Dennis Konnerup**
**(deko@seges.dk)**

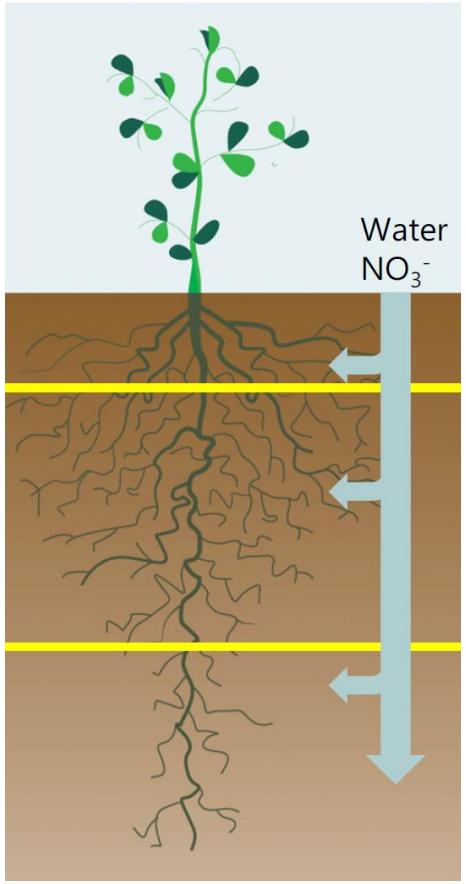
**22 January 2026**

SEGES INNOVATION

# Why measure nitrate leaching?

Understanding leaching patterns supports better N fertilizer timing, rate, and source, improving yield while reducing losses

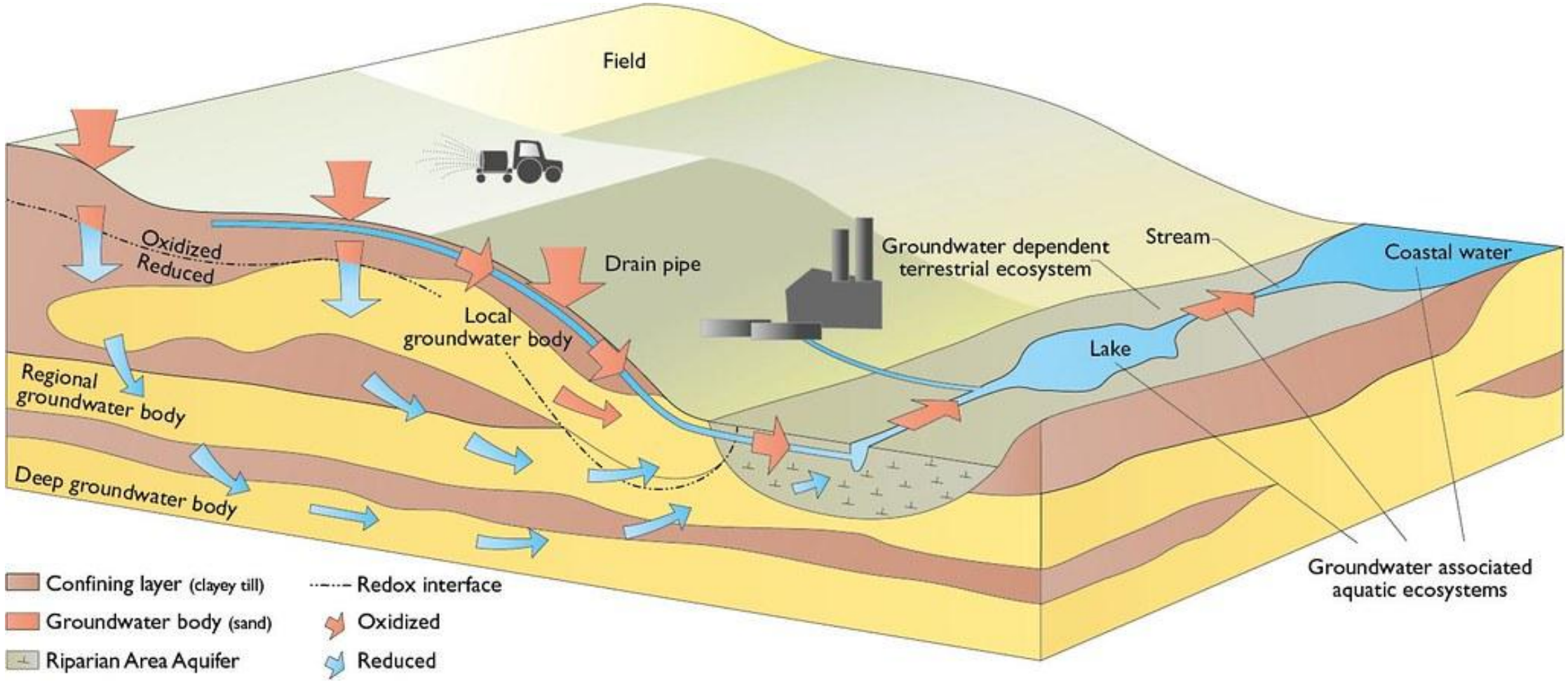
Leached nitrate can eventually reach groundwater, streams, lakes, and coastal waters




(Thorup-Kristensen et al 2020)

SEGES INNOVATION

# Nitrogen flows




(Hinsby et al 2012)

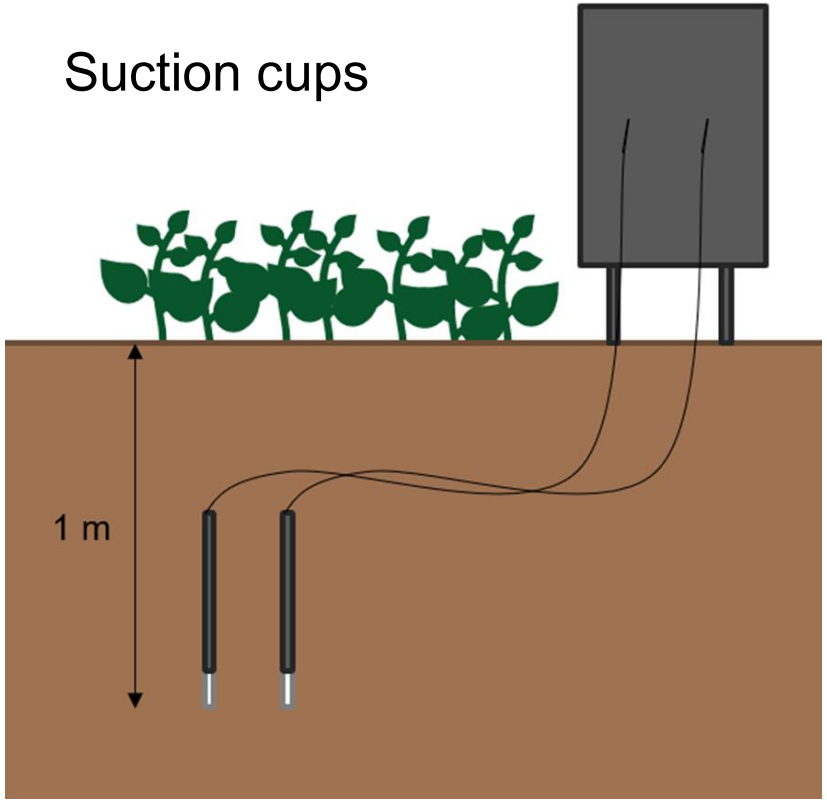
# How to measure nitrate leaching?

## Ceramic suction cups installed in the subsoil

Can be installed in large numbers throughout an experimental field

This allows for frequent measurements from the same location, thus beneficial for year-round, multi-plot, field experiments

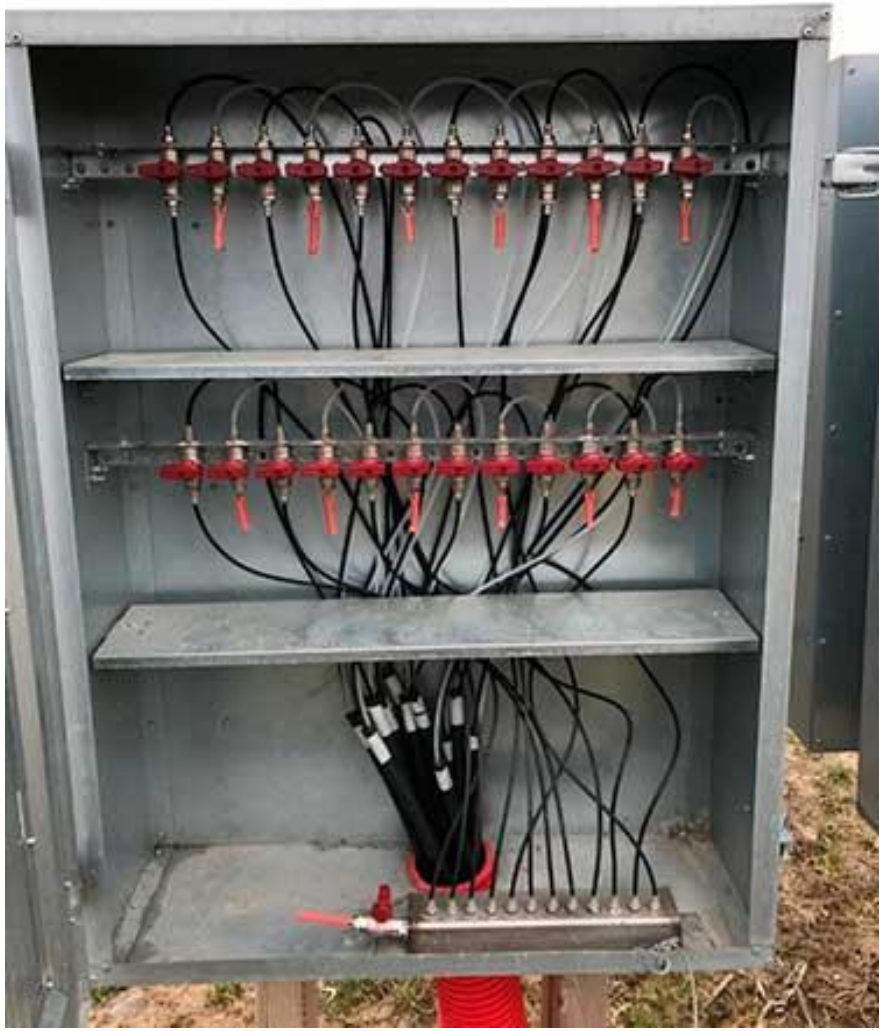
Can remain installed for long periods of time covering a significant portion of the year, as long as there is sufficient moisture in the subsoil




SEGES INNOVATION

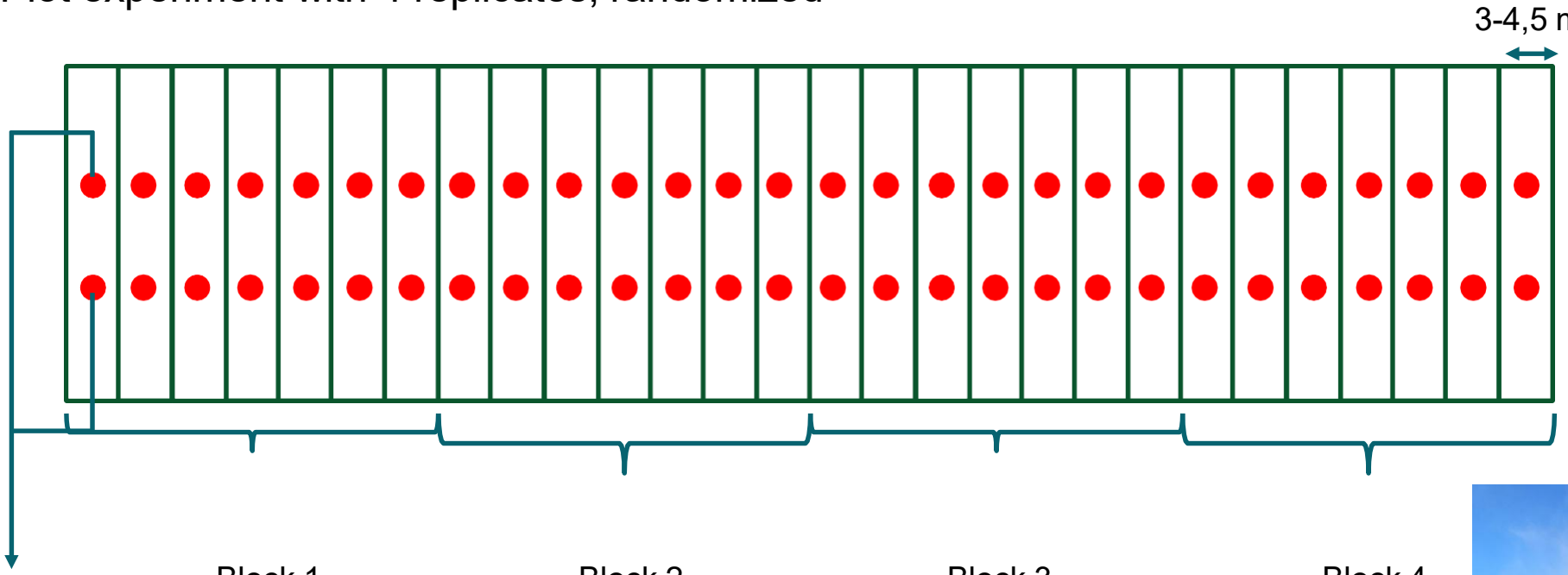
# Installing suction cups

It can take time for the soil to settle after installation



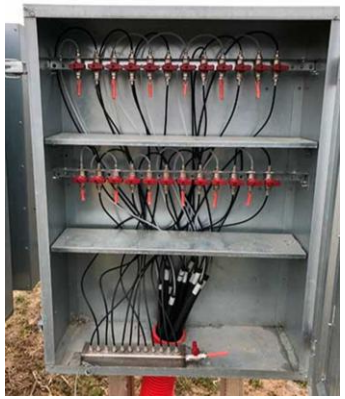
# Sampling water from suction cups

Plot experiment with 4 replicates, randomized




- Samples are taken every 14 – 20 days
- Vacuum applied 2-3 days before sampling
- There must be at least 20 ml of soil water in a sample
- Samples to be transported in a cooler

Samples from same plot are mixed in a 1:1 ratio before analysis



# Calculation of leaching

Climate data: Precipitation and potential evaporation – from weather station or 10km x 10 km grids

Water balance: Daily percolation is modelled (E.g. using EVACROP)

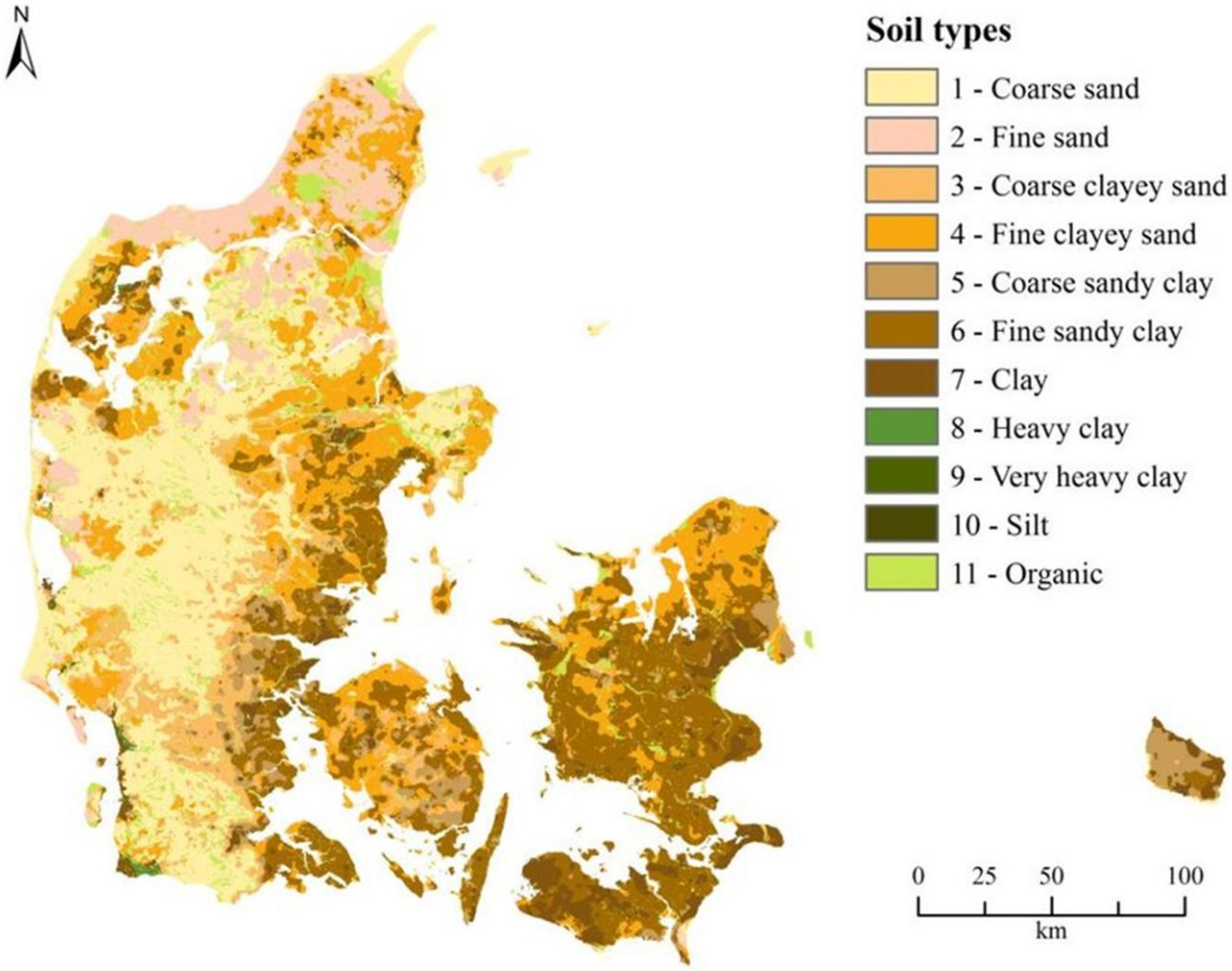
Concentrations: Interpolated with weighted percolation

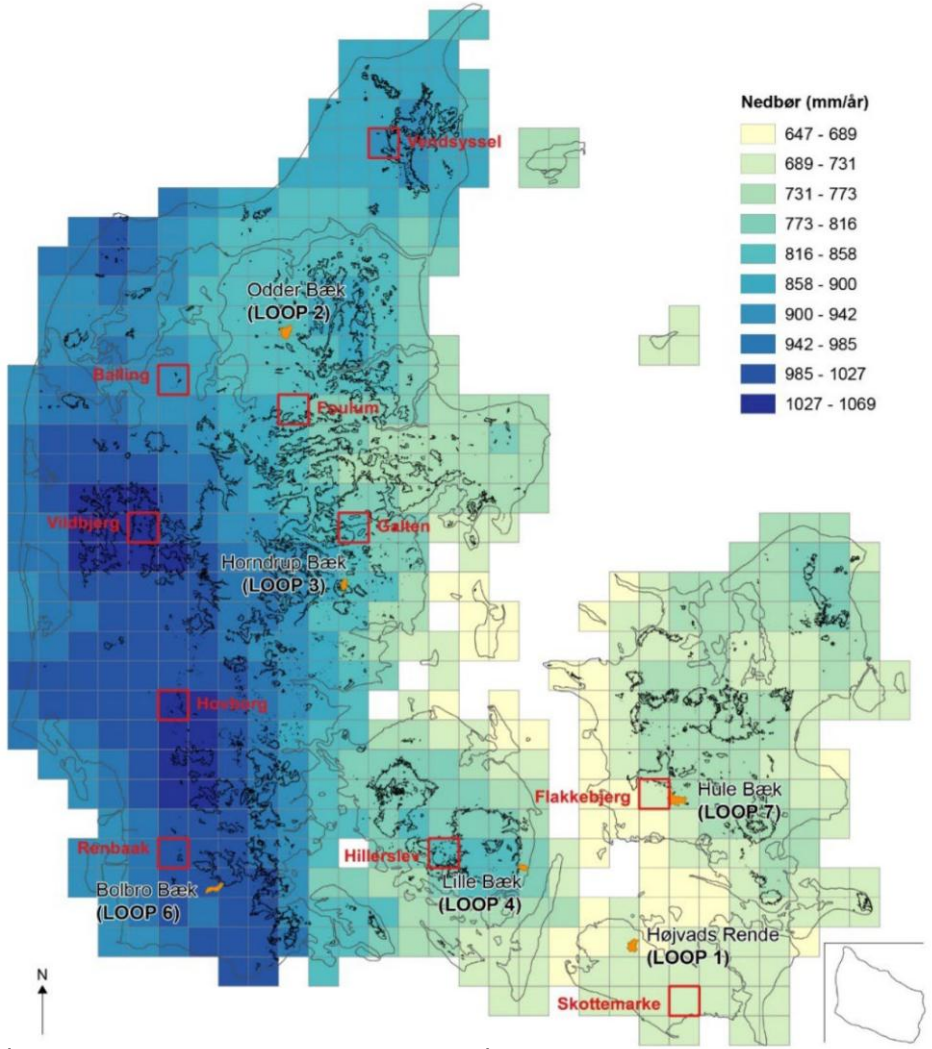
Daily leaching calculated as:
Daily concentration x daily percolation

Daily leaching is summed up to yearly or monthly leaching

| Day | Percolation, mm | % of percolation in period | Measured concentration | Interpolated concentration |
|---|---|---|---|---|
| 1 | 0 | 0 | 15 | 15,0 |
| 2 | 0 | 0 | - | 15,0 |
| 3 | 5 | 12,5 | - | 14,4 |
| 4 | 10 | 25 | - | 13,1 |
| 5 | 0 | 0 | - | 13,1 |
| 6 | 20 | 50 | - | 10,6 |
| 7 | 5 | 12,5 | - | 10,0 |
| 8 | 0 | 0 | 10 | 10,0 |

# Leaching depends on soil type and precipitation



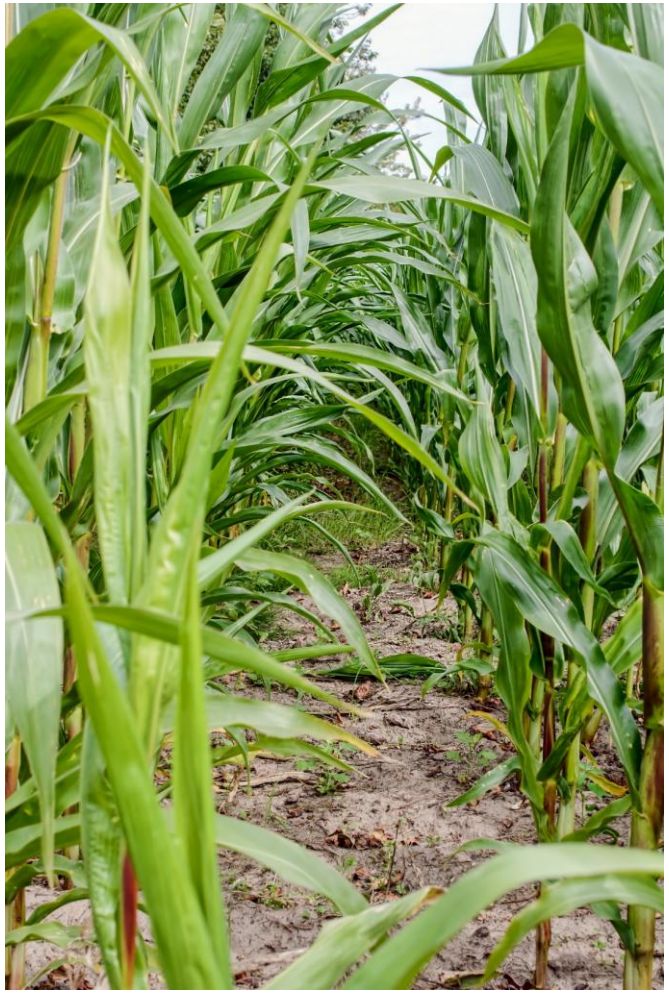




(Blicher-Mathiesen et al 2024)

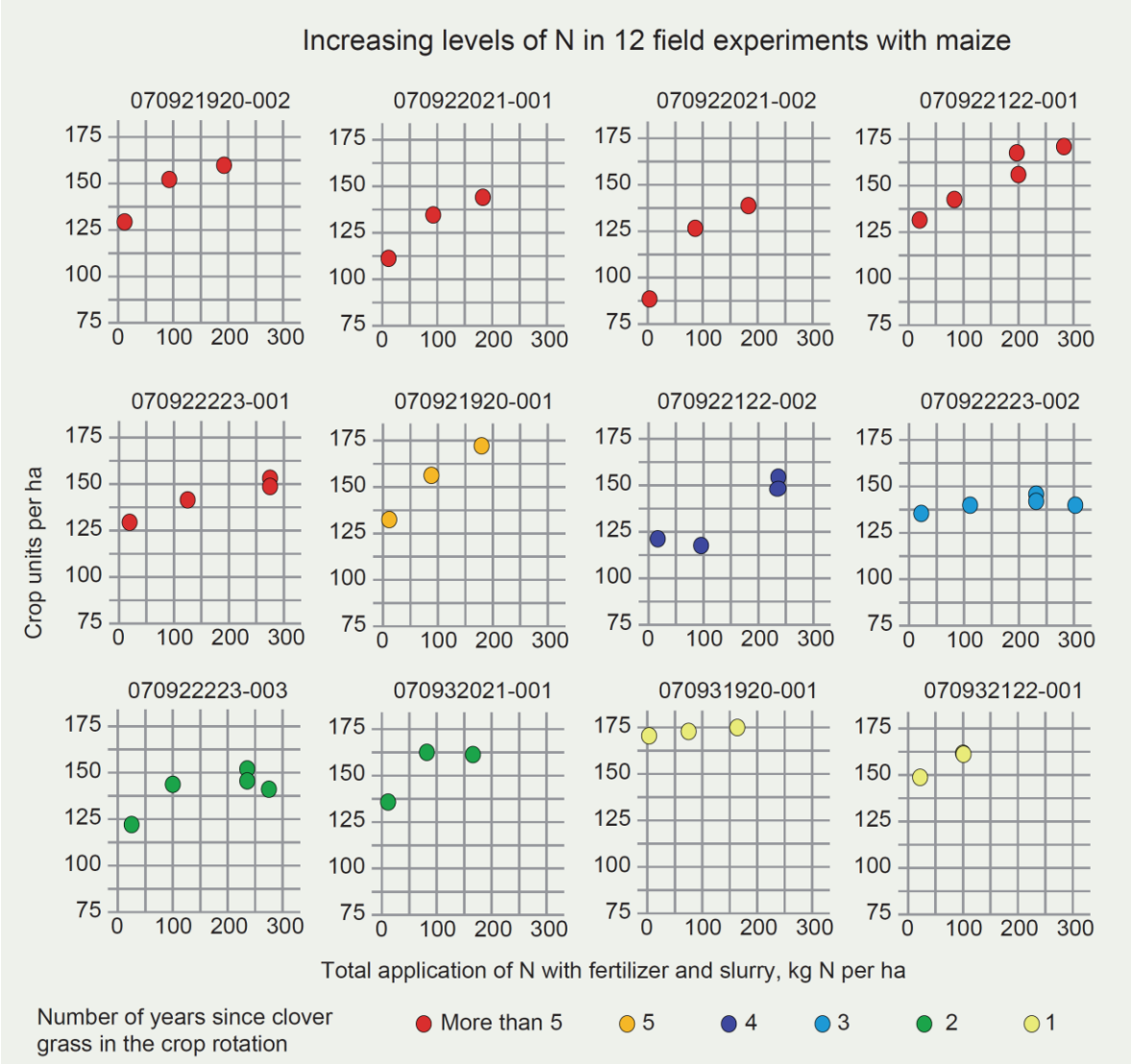
# Maize

Nitrate leaching from maize in Denmark is higher than from most other agricultural crops due to several factors:

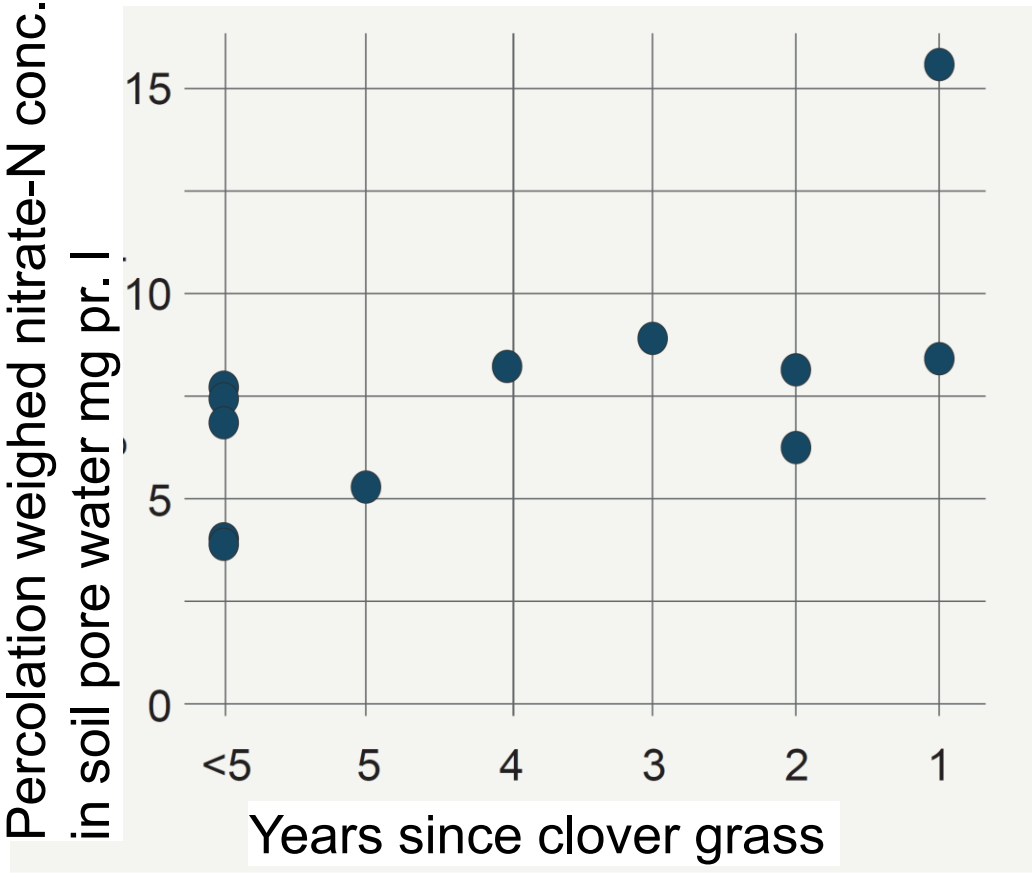
- It is often grown on sandy soils and in areas with high precipitation.
- Maize has a high nutrient demand, and large amounts of slurry are often supplied
- It can be difficult to establish cover crops because of late harvest.



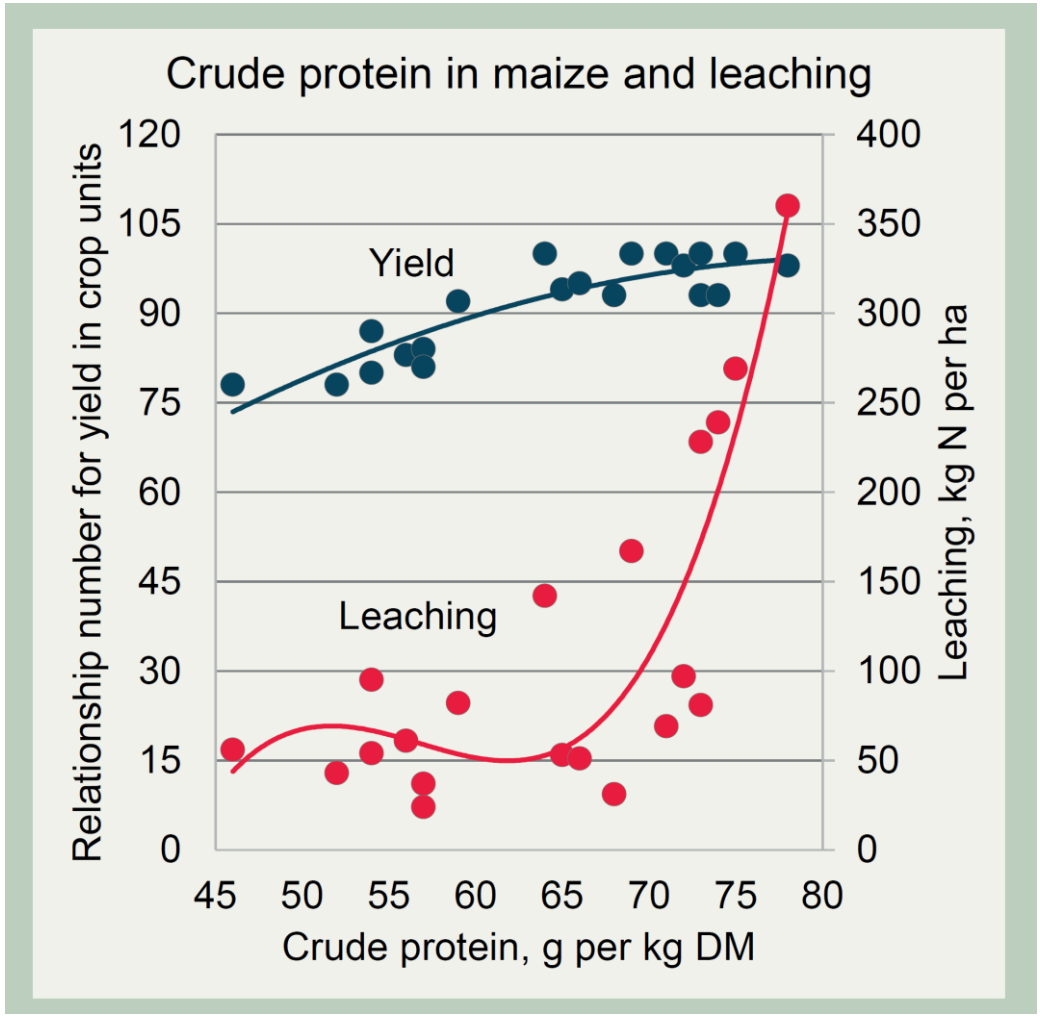
# Maize after clover grass

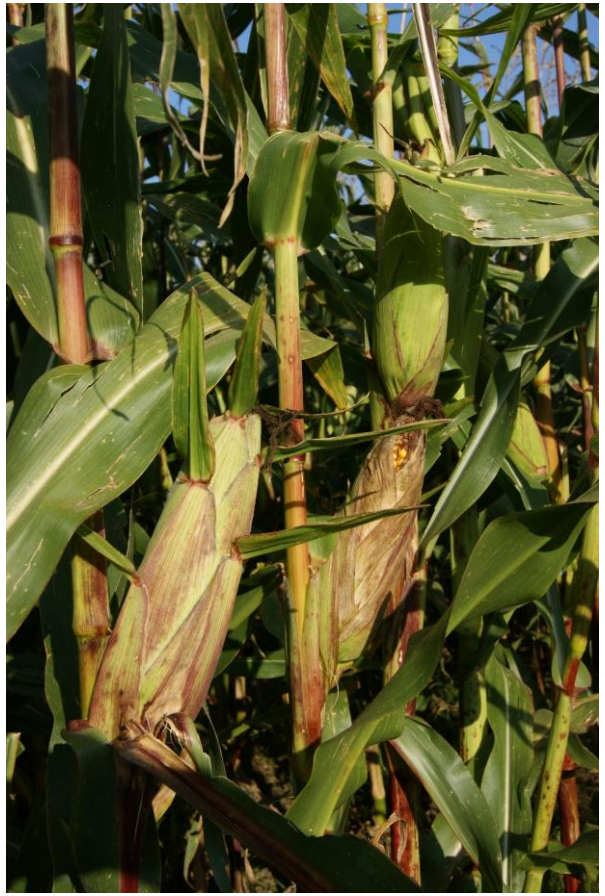



(Landsforsøgene 2023) (The Danish National Field Trials 2023)



# Maize protein and leaching



(Landsforsøgene 2023) (The Danish National Field Trials 2023)

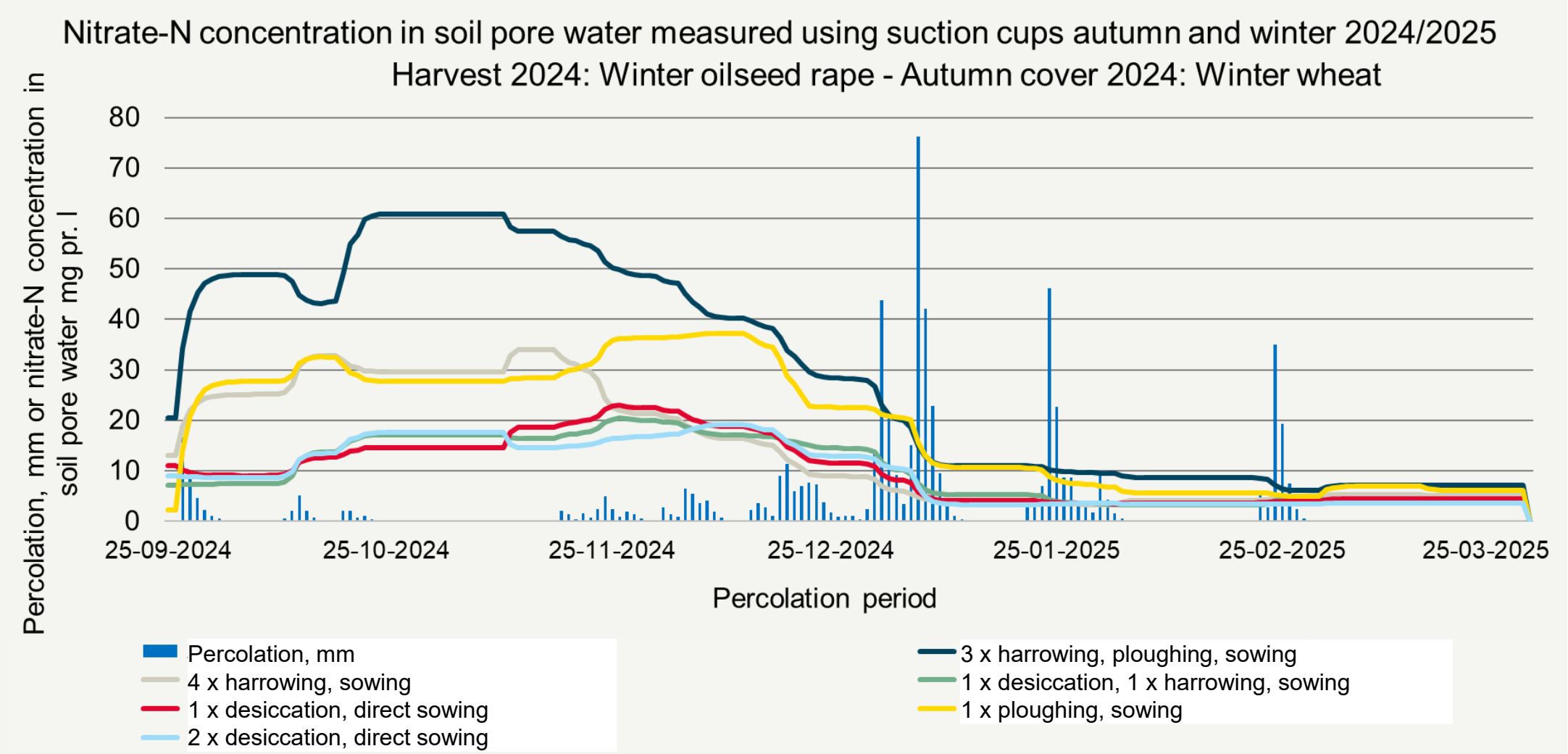
# Catch crops in maize

Maize 2019-2023, 12 experiments

| Catch crop | Time for sowing of catch crop after maize | Leaching and additional leaching, kg N pr. ha | Additional leaching, % | Yield and additional yield, crop unit pr. ha | Additional yield, % |
|---|---|---|---|---|---|
| | | | | | |
| Perennial ryegrass | 6 weeks | 103 | - | 155 | - |
| Perennial ryegrass | 4 weeks | -18 | -17 | -3 | -2 |
| Chicory + perennial ryegrass | 4 weeks | -32 | -31 | -4 | -3 |
| Chicory | 4 weeks | -30 | -30 | | |
| Tall fescue | Same time | -21 | -20 | -18 | -12 |
| Tall fescue | 2 weeks | -31 | -30 | -9 | -6 |
| | | | | | |

(Landsforsøgene 2023) (The Danish National Field Trials 2023)

# Effects of reduced tillage on nitrate leaching




(Landsforsøgene 2025) (The Danish National Field Trials 2025)

SEGES INNOVATION

Promilleafgiftsfonden for landbrug

# Thank you for your attention

SEGES
INNOVATION