KNOWLEDGE CENTRE FOR AGRICULTURE

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Controlled drainage as a measure to reduce the outlet of nitrogen to the aquatic environment

A green development and demonstration project

Ministeriet for Fødevarer, Landbrug og Fiskeri
NaturErhvervstyrelsen
gudp

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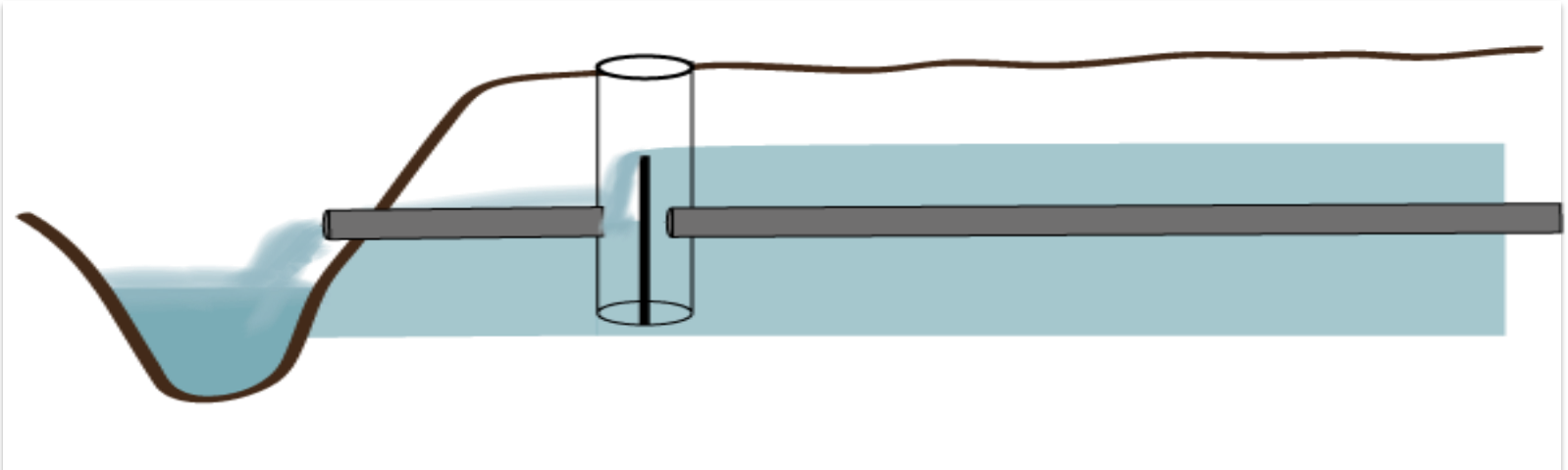
Project: Controlled drainage as a measure to reduce the outlet of nitrogen to the aquatic environment (2012-2015)

Objective:

To obtain the necessary documentation so that controlled drainage can be recognized as a measure to reduce the outlet of nitrogen and phosphorus to the aquatic environment (in order to meet the goals of the WFD)



Results from international studies

- Swedish experiments on controlled drainage showed that losses of N could be reduced by 78-94 % and losses of P were reduced by 58-85 % (Wesström et al., 2001, Wesström et al., 2007).
- In the US controlled drainage has been applied for a number of years, mainly targeted towards root irrigation (Thomas et al., 1995).
- Woli et al. (2010) found that N export from controlled drainage systems was 2/3 lower than N export from traditional drains

- Most studies were made for spring-sown crops

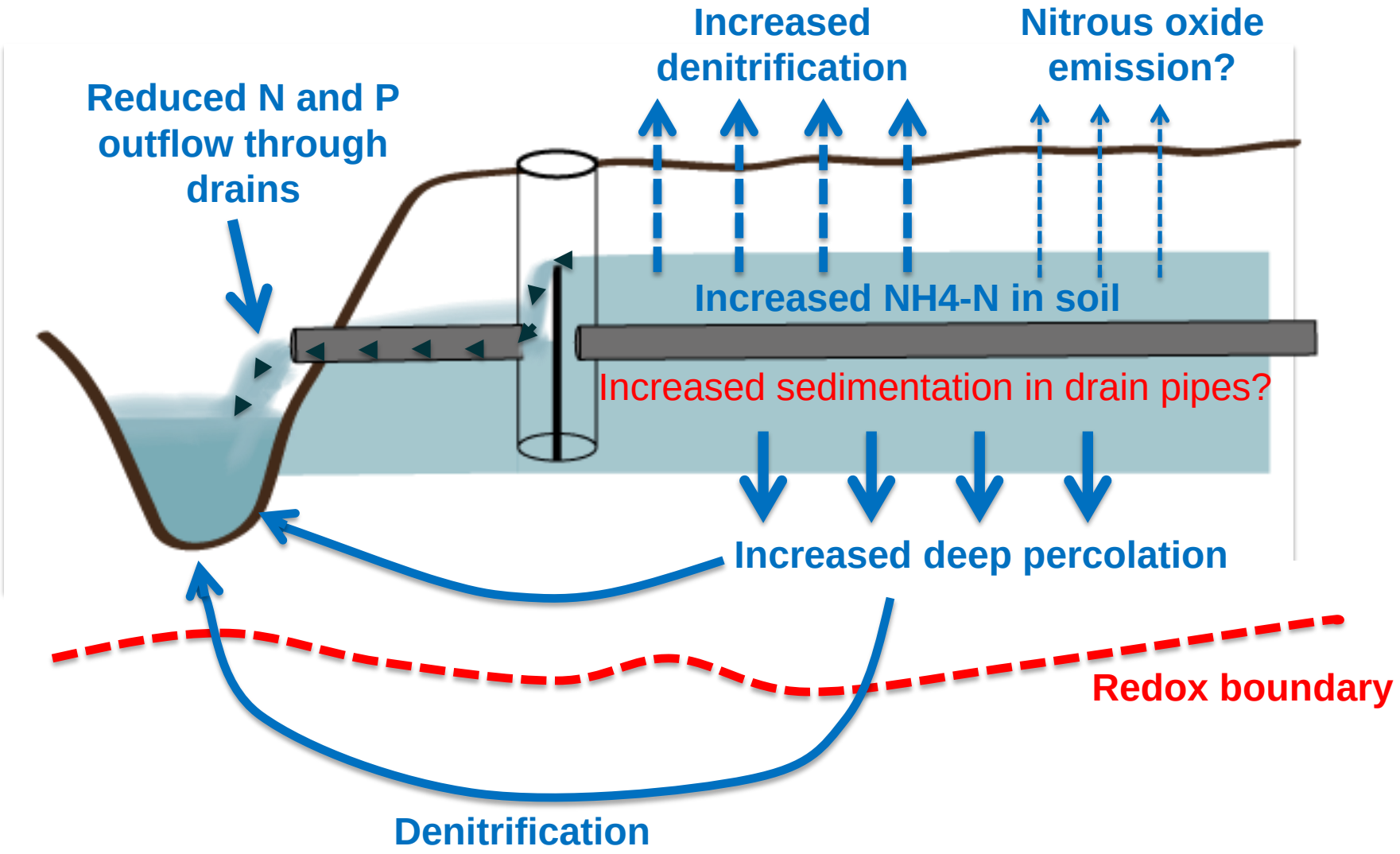
Controlled drainage: potentials and drawbacks

- Increase denitrification:
  Soil water content is increased during autumn and spring when crop root depth is still shallow and there is no need for field management. During autumn there are relatively warm soils and a high content of nitrate in the field soil that could potentially be leached during winter.
- Water storage buffer: Hold back water during early spring for root irrigation etc.

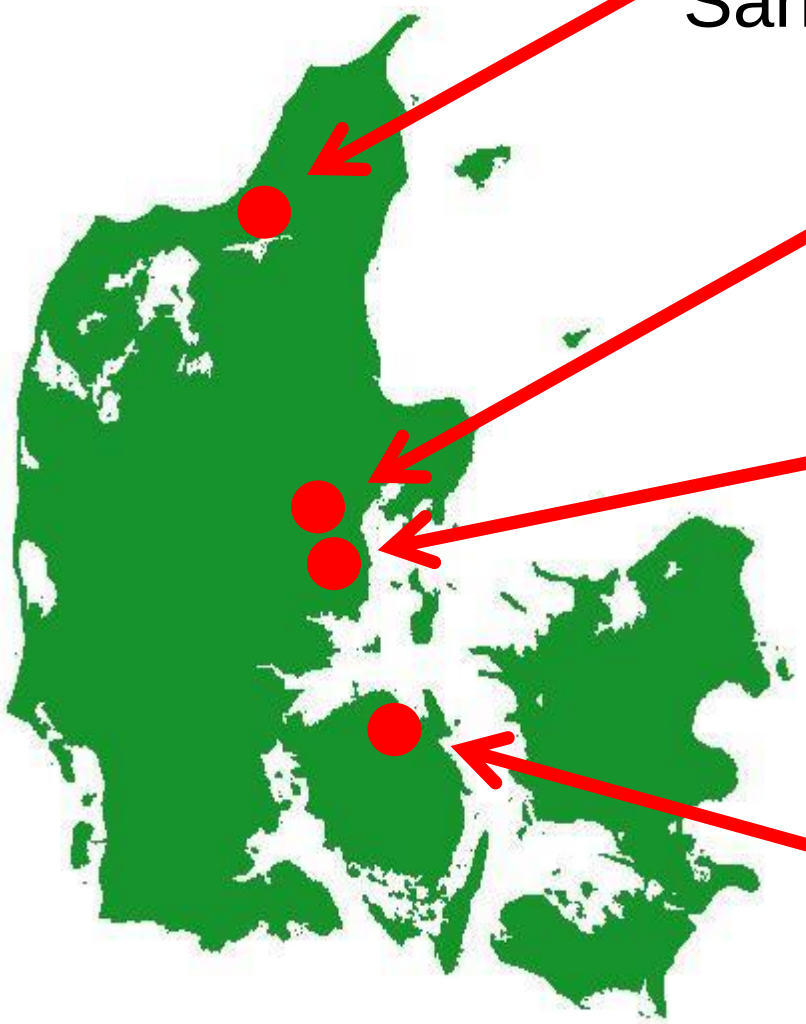
- Increased sedimentation in drainage pipes?
- Increased N2O emissions?

Effects of controlled drainage

Water level is raised during autumn and winter



Controlled drainage demonstration sites in Denmark



Birkelse (2012)
Sandy soil. Ditch drainage

Bredkjaer (2012)
Clay soil. Pipe drains.

Hedemark (2012)
Clay soil. Pipe drains.

Hofmansgave (2012)
Sandy soil. Pumped area.

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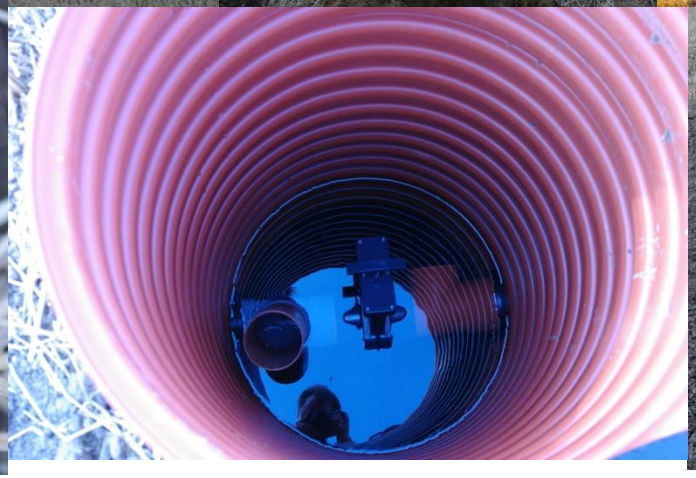
Experimental fields established

Soil characterisation

Summer 2012




Hedemark
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29.08.2012
SørenTorp

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Site: Bredkjær

Site: Hedemark

Measurements

- Research plots established at the four sites (2012 - 2013).
- All sites are cropped to winter wheat
- At each site there are plots with/without changed drainage height.
- Crop growth conditions etc are noted at all plots
- N og P losses in drain water are measured
- More intensive measurements at two sites where crop growth and N dynamics in the soil are investigated
- Yields of winter wheat are measured
- N_2O-emmisions are measured at one site (campaigns)
- The potential for the implementation of controlled drainage will be estimated at a regional Danish scale

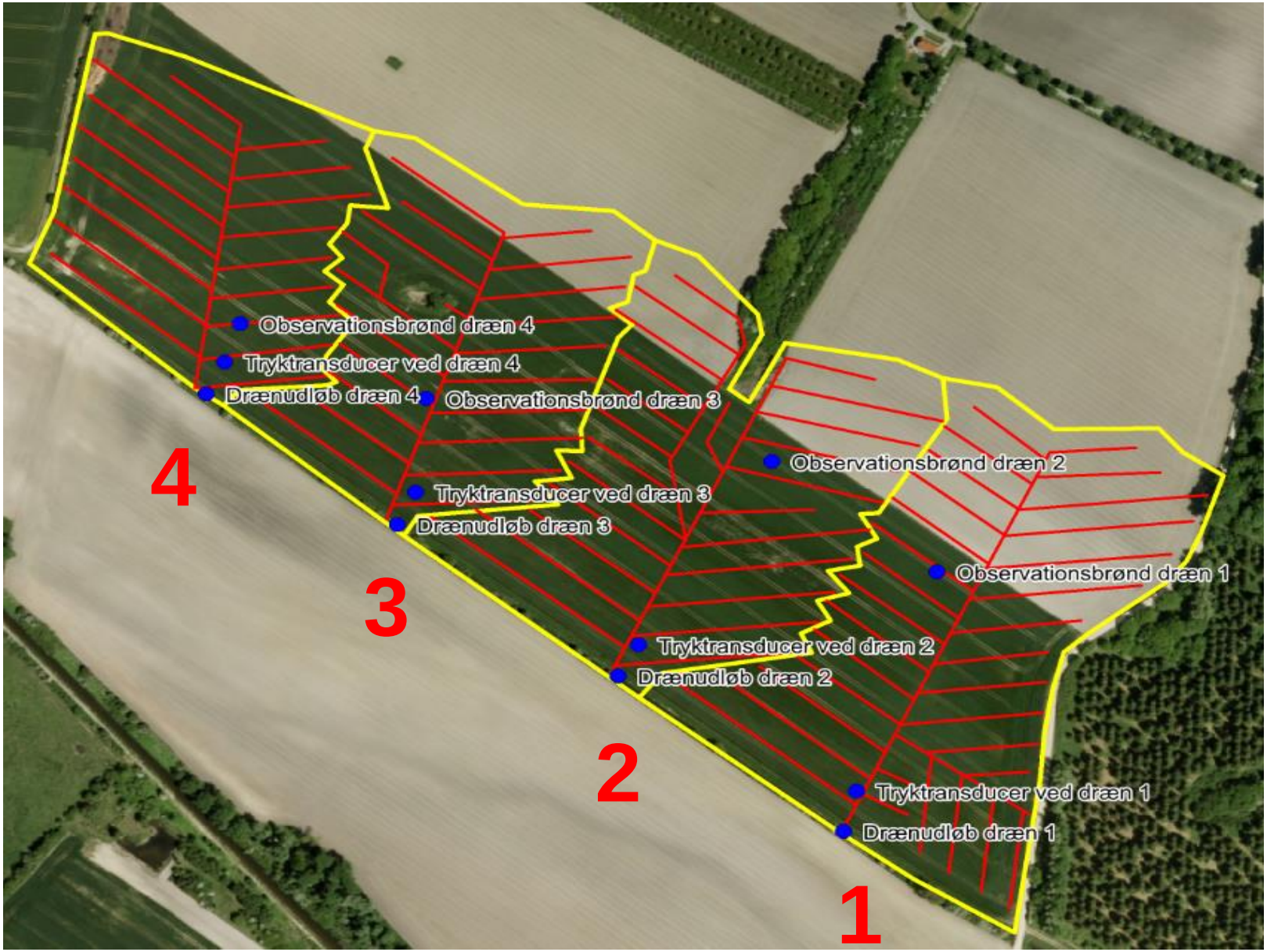
Hofmansgave demonstration site

Crop rotation:
Maize – winter wheat

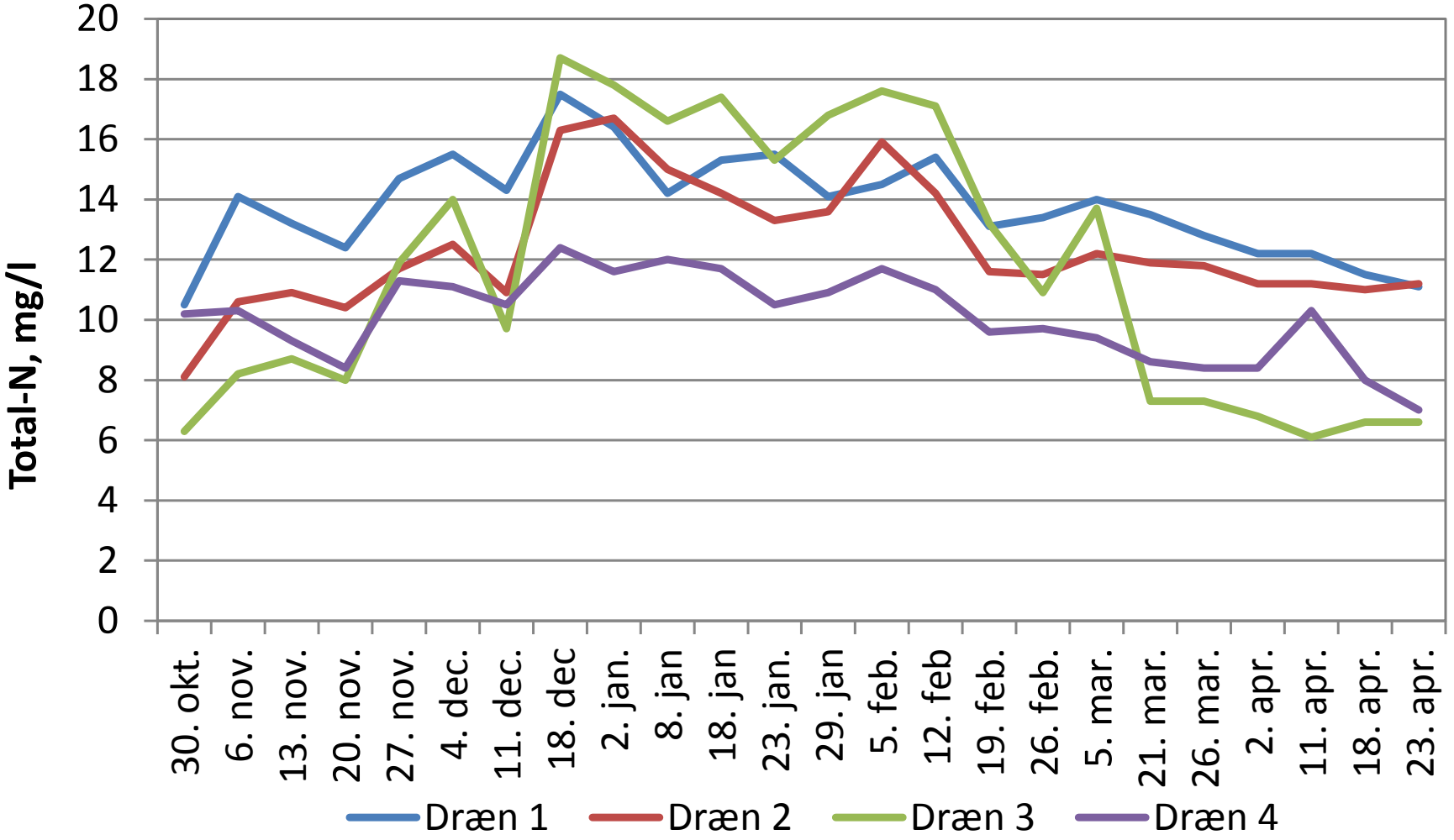
Control well

Measuring well

Drainage system at Hofmansgave



Nitrogen in drainage water at Hofmansgave 2012-13 (reference year), mg N/l (total-N)



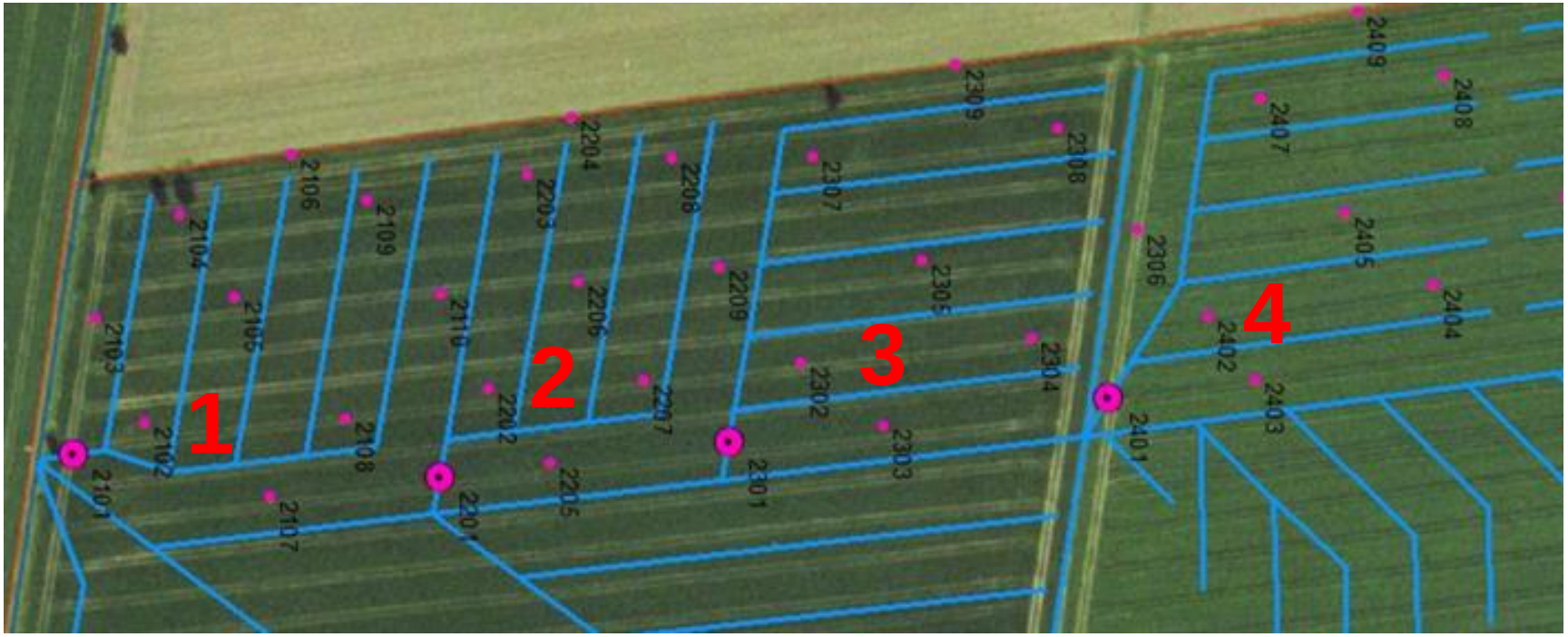
Outlet of nitrogen from drain 1-4 at Hofmansgave 2012-13 (reference year)

	Ha	Runoff, mm	Total-N mg/l	Kg N per ha	Kg N per 210 mm
Drain 1	6,2	213	15,0	32	32
Drain 2	5,4	241	13,3	32	28
Drain 3	4,2	288	14,9	43	31
Drain 4	3,8	282	10,6	30	22

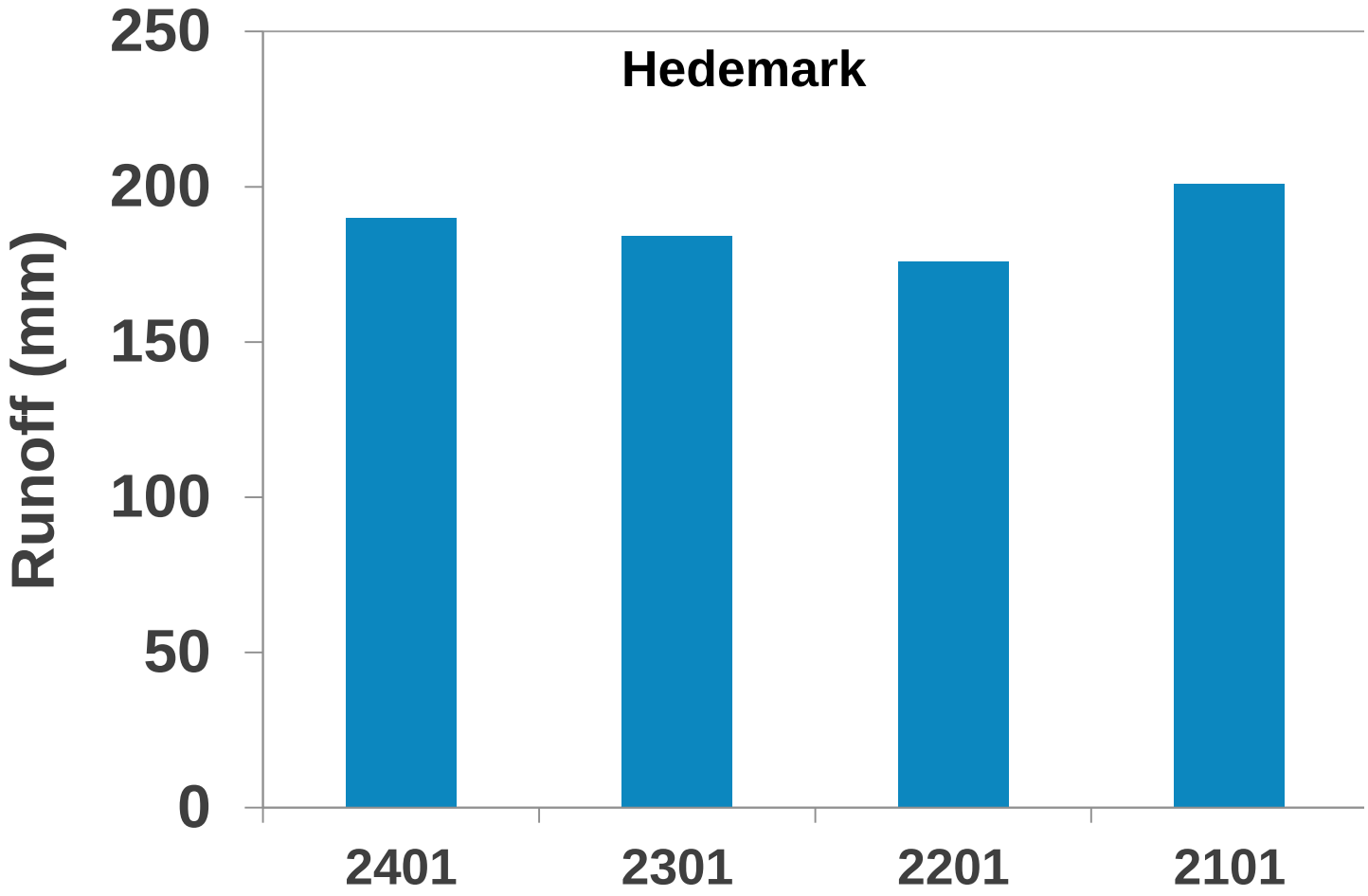
Percolation: 210 mm in 2012-13

Hedemark demonstration site

- 4 separate drainage systems (0,8 – 1,2 ha)
- Crop rotation: Winter wheat every year
- Clay soil (~20% clay)



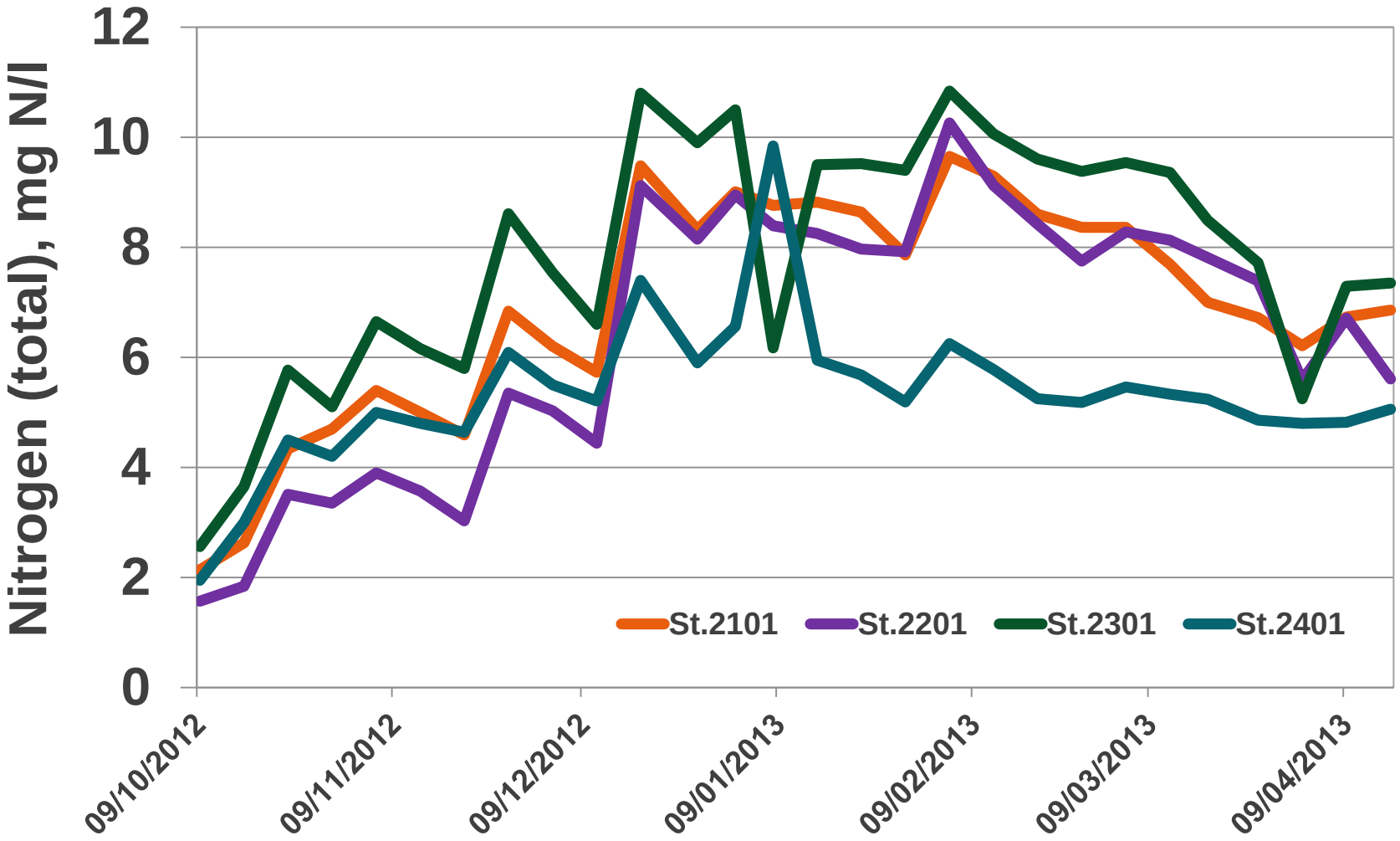
Runoff at Hedemark 2012-13 (reference year)



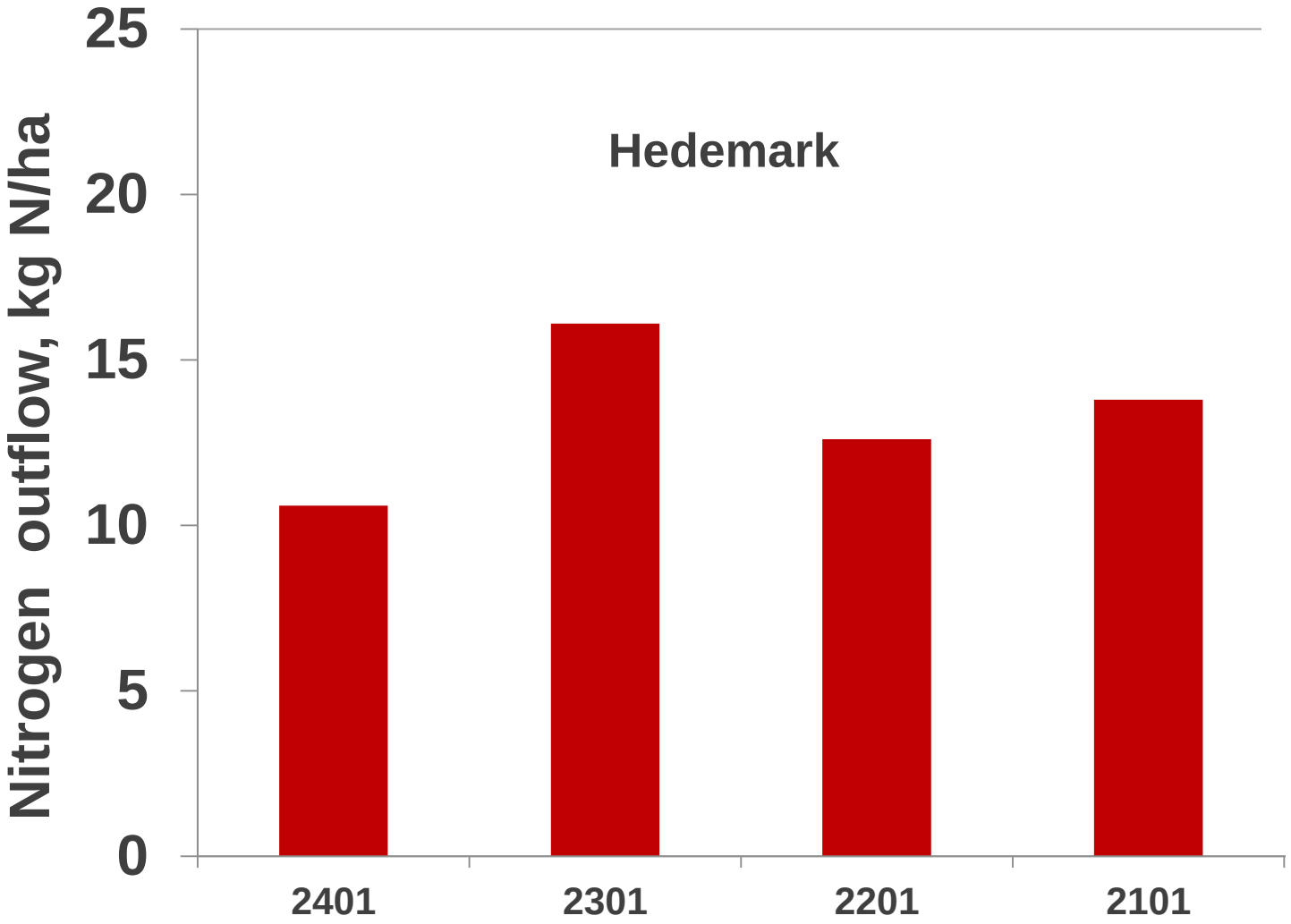
Percolation in 2012-13: 240 mm

70-80 of the percolation has run-off through the drainage system

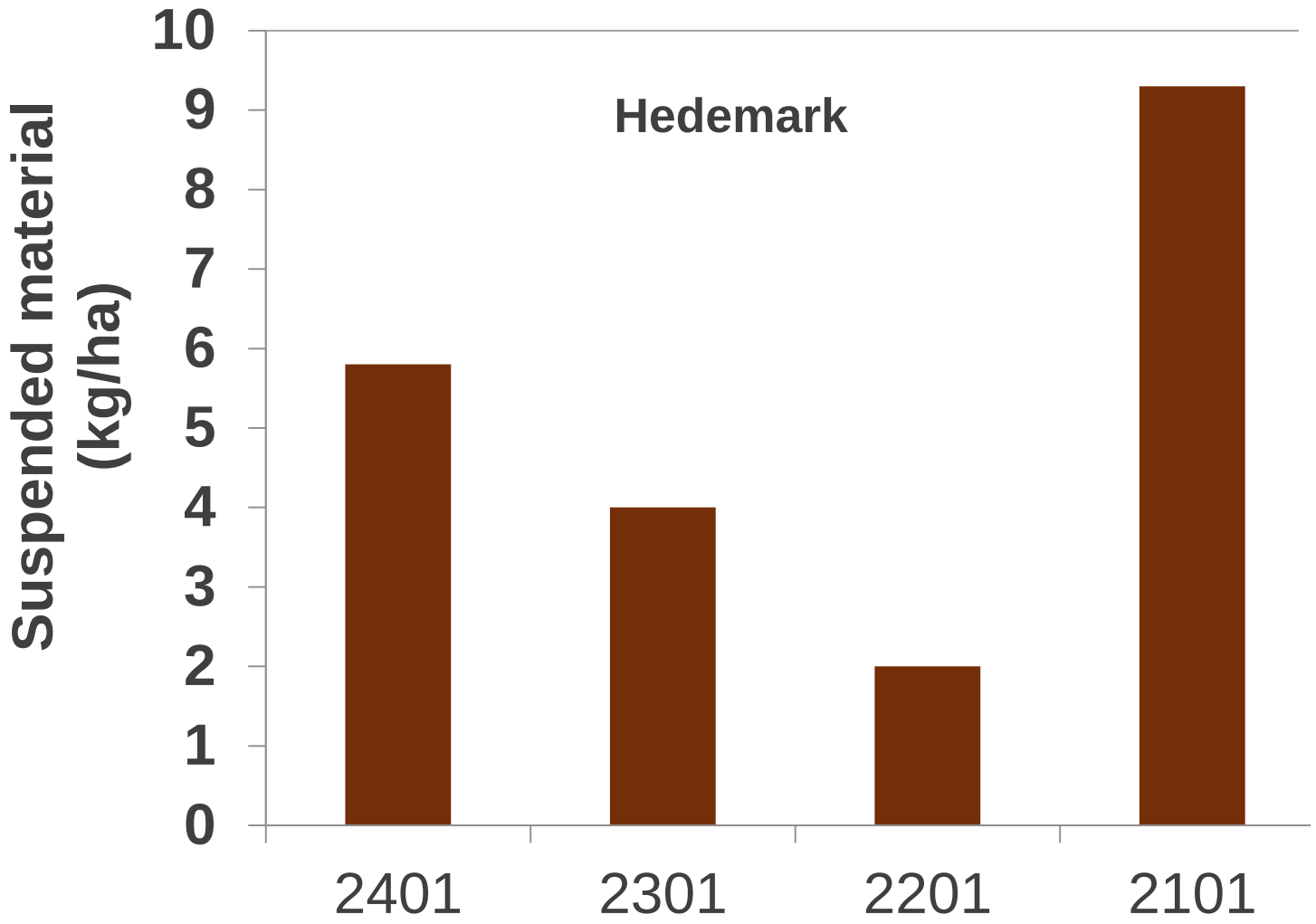
Nitrogen content in drainage water at Hedemark 2012-13



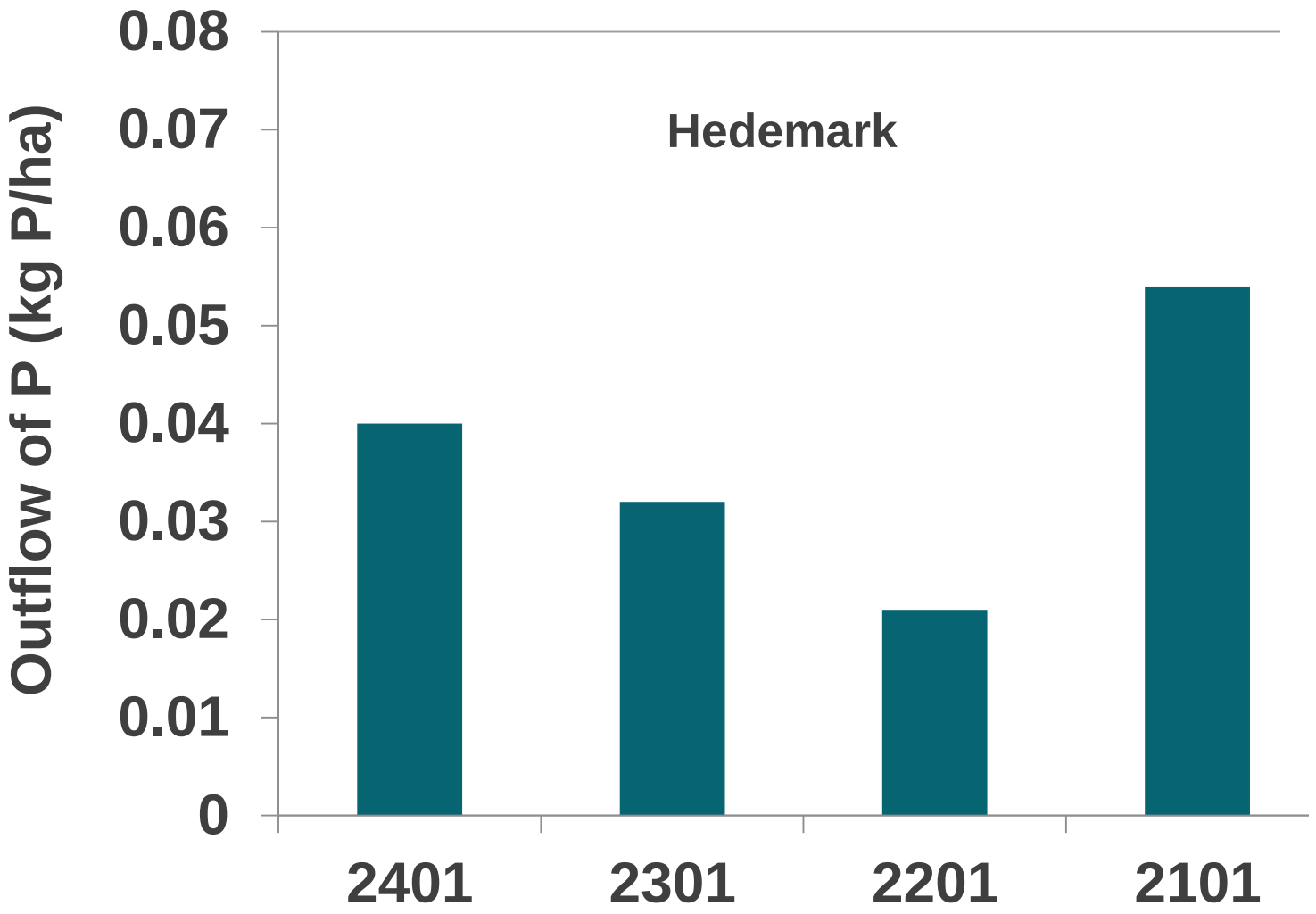
Outflow of nitrogen through the drainage system at Hedemark 2012-13



Outflow of suspended material through the drainage system at Hedemark 2012-13

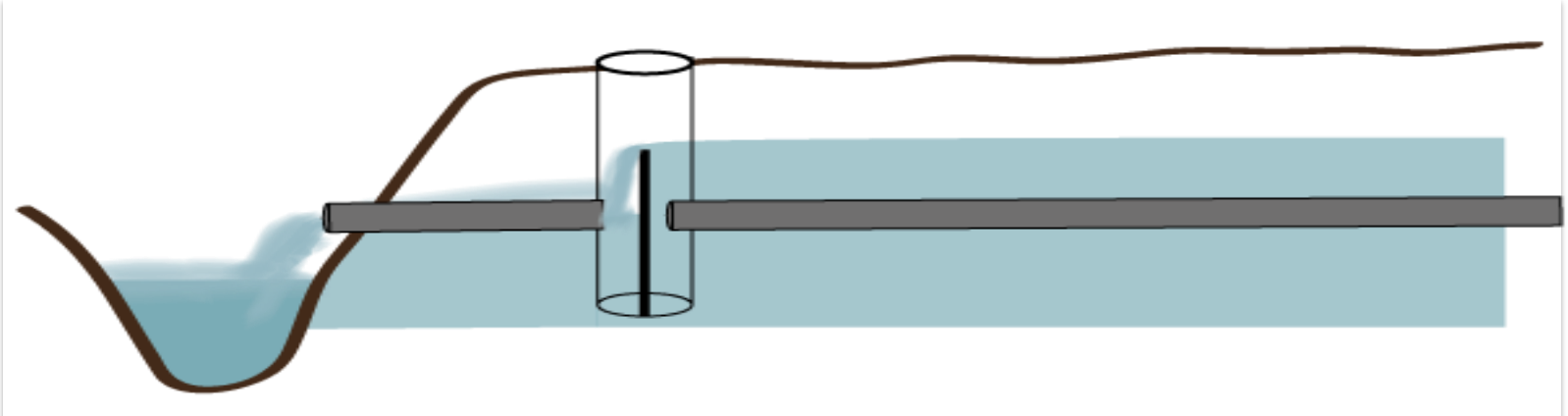


Outflow of phosphorus through the drainage system at Hedemark 2012-13

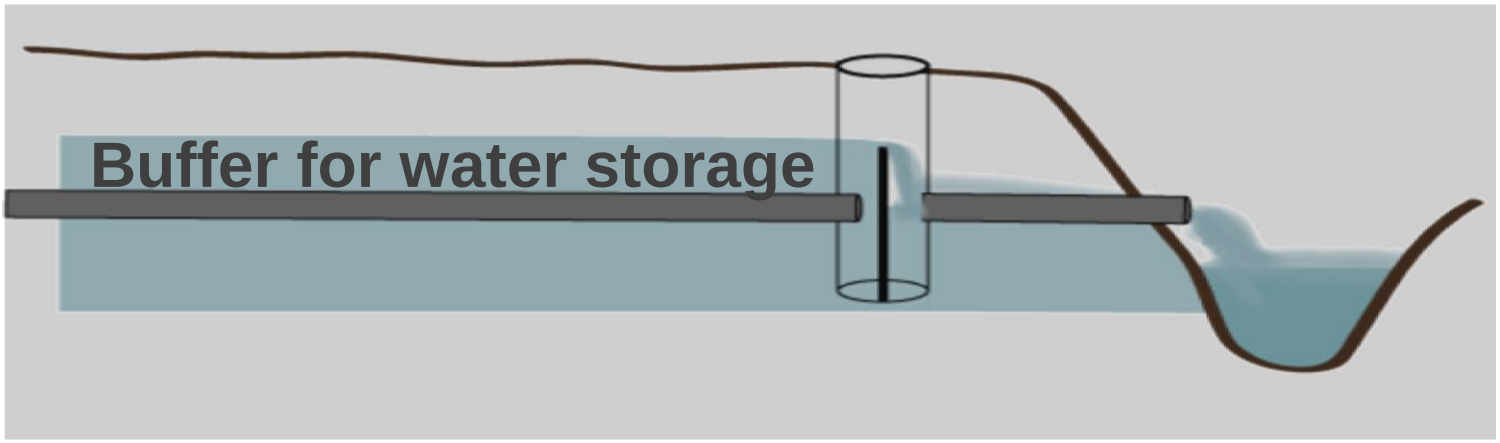


Implementation of controlled drainage (CD) in Denmark

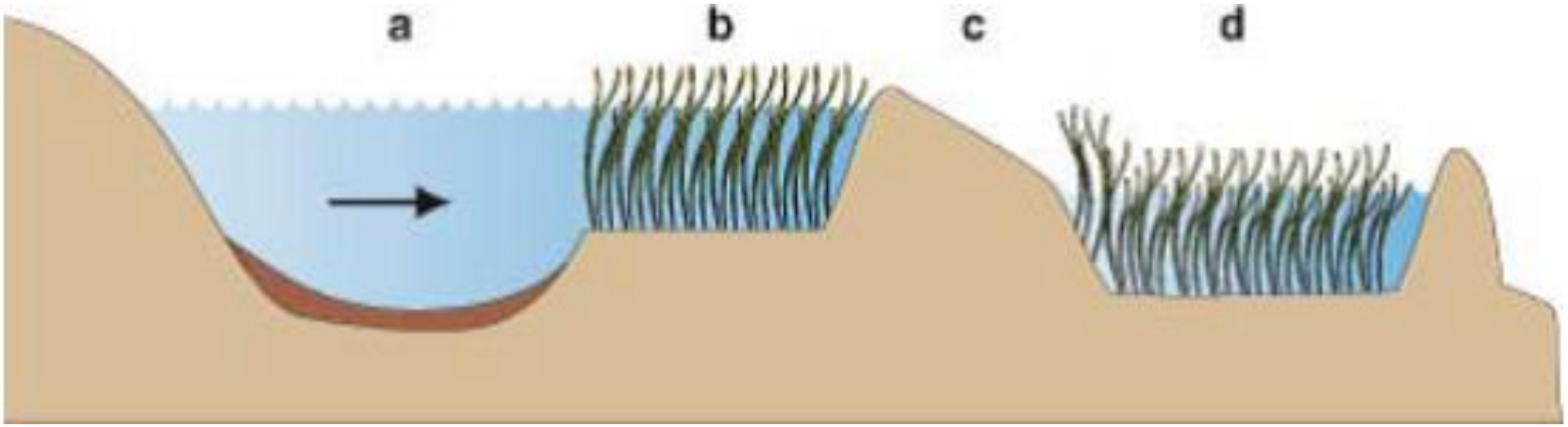
- IN 2016 CD is hopefully a recognized measure
- Maybe 10 % of the agricultural area is suitable for CD
- CD is probably not profitable for the farmer by itself
- Maybe CD is profitable as an alternative to compulsory catch crops and reduced N quotas
- CD will probably often be combined with constructed wetlands and riparian buffer zones in order to optimize nitrogen removal



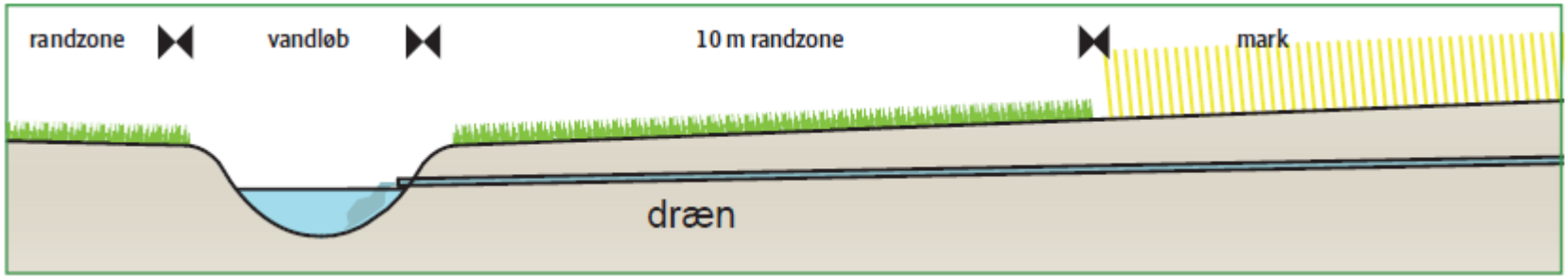
Constructed wetlands

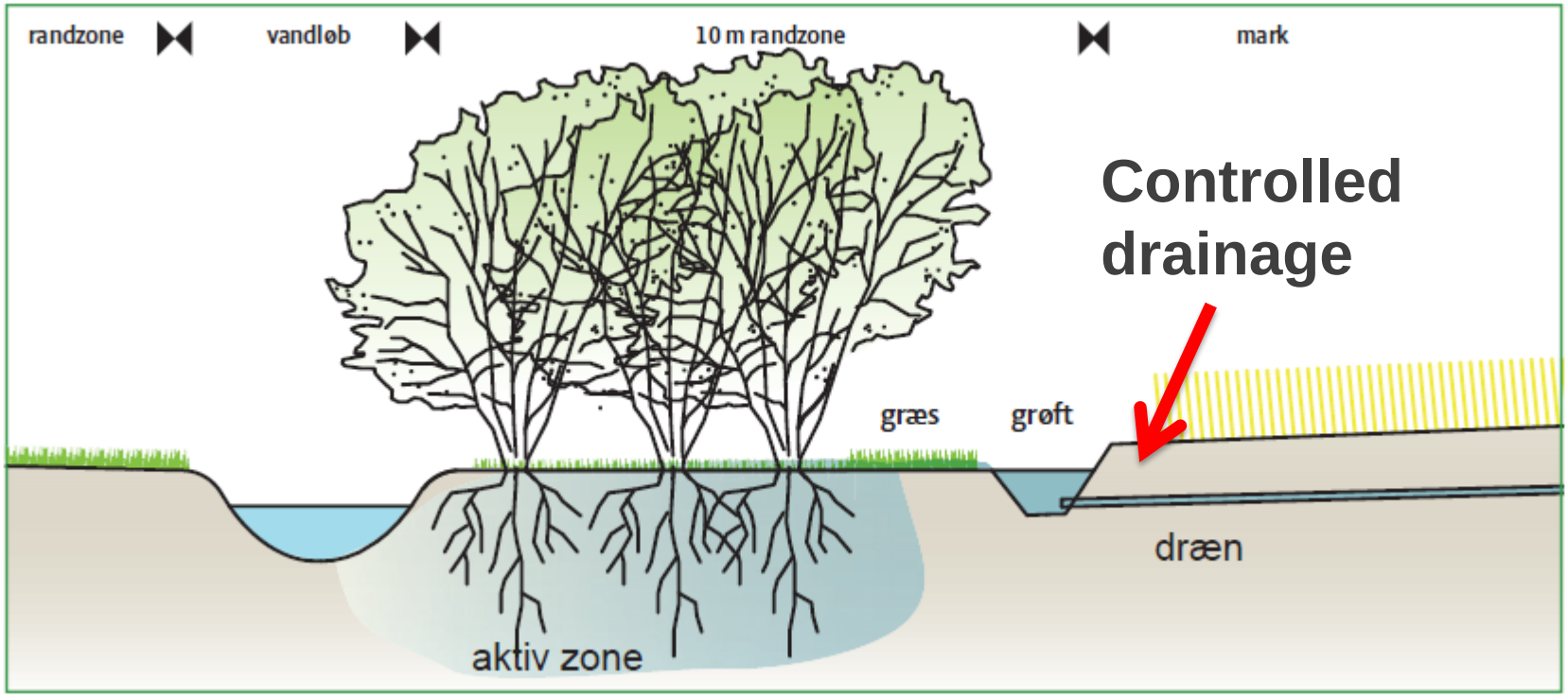


Controlled drainage can level out the inflow of drainage water to a constructed wetland



Riparian buffer zones





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Thank you for your attention

Project homepage:
www.vfl.dk/kontrolleretdraening