

The effectiveness of different mitigation measures for nitrogen pollution is altered by interactions between mitigation measures - considerations for implementation of measures in modelling and mitigation policies

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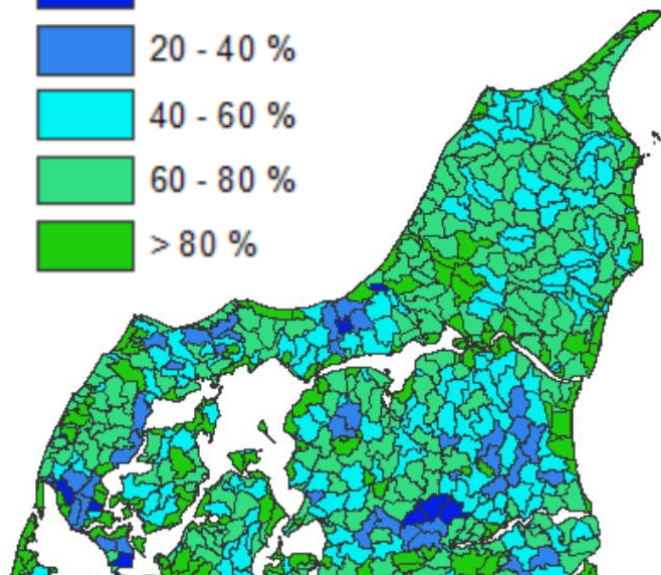
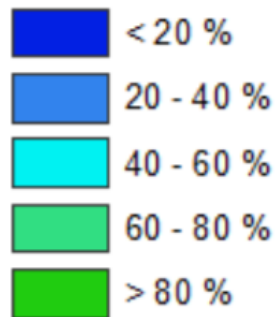
STØTTET AF
promilleafgiftsfonden
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How to comply with WFD?

The water framework directive calls for further reductions in nitrogen loading to costal waters!

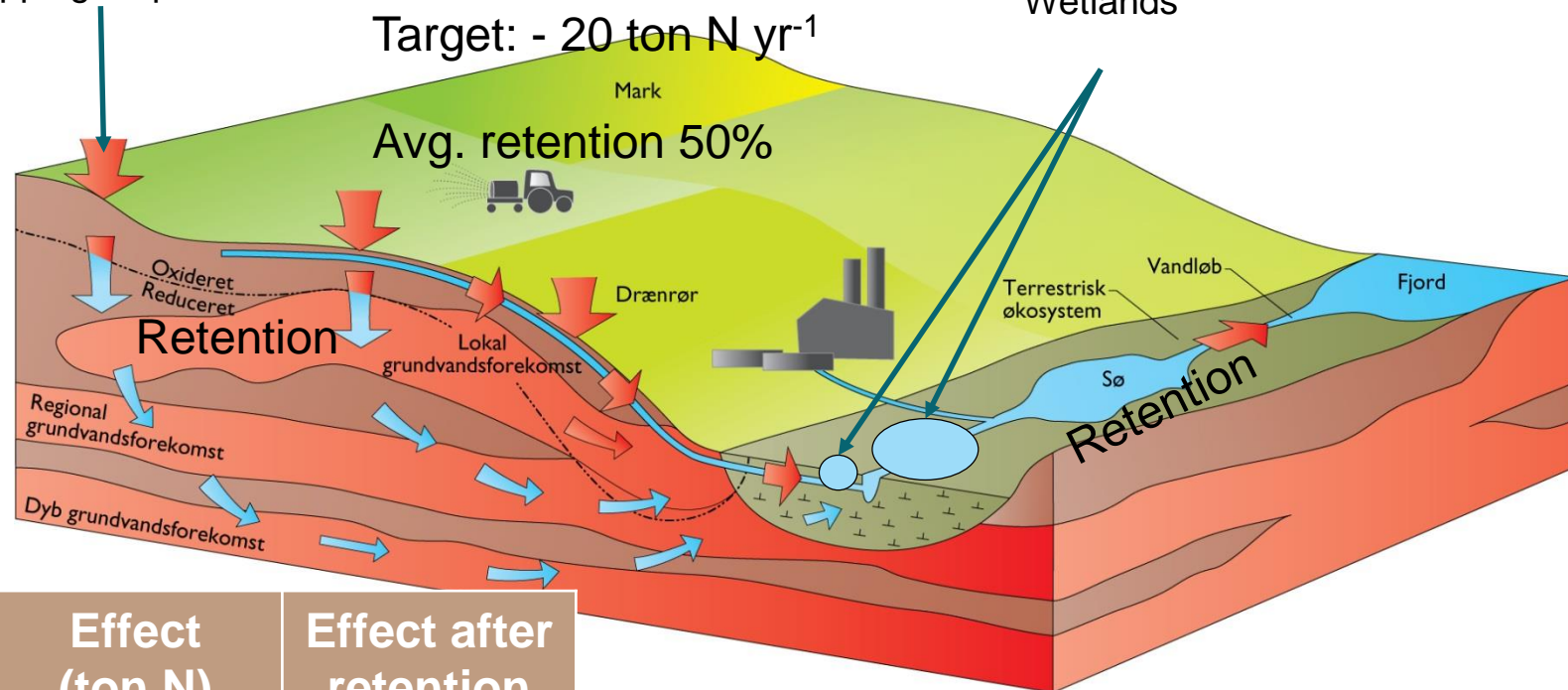
How can reductions in nitrogen loading be achieved in a cost effective way?

Catchment modelling



Reduce leaching
Catch crops
Reduced nitrogen application
Cropping sequence

Increase N retention
(end of pipe solutions)
Constructed wetlands or Integrated buffer zones
Wetlands

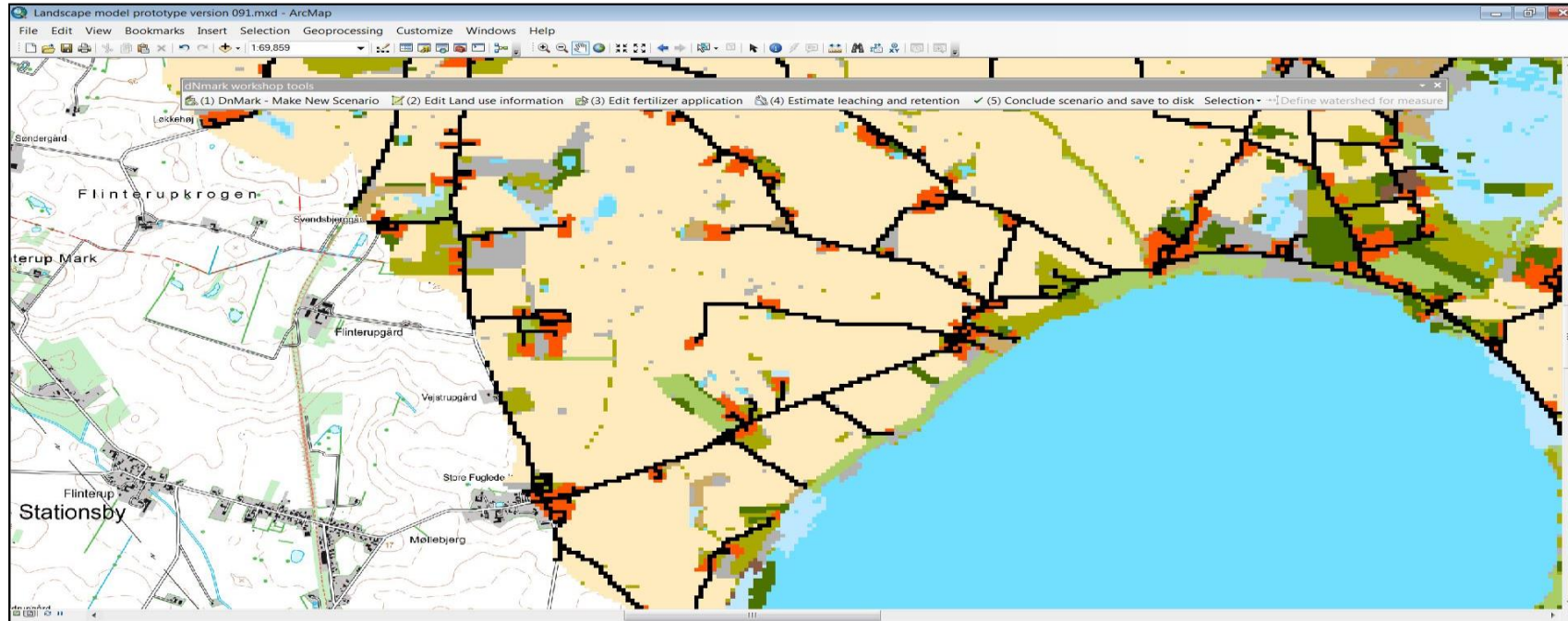


Measure	Effect on leaching (kg N ha ⁻¹)	Area (ha)	Effect (ton N)	Effect after retention (ton N)
Catch crops	25	1000	25	12,5
Reduced N application	4	1000	4	2
Wetland	150	80	12	6
Total			41	20,5

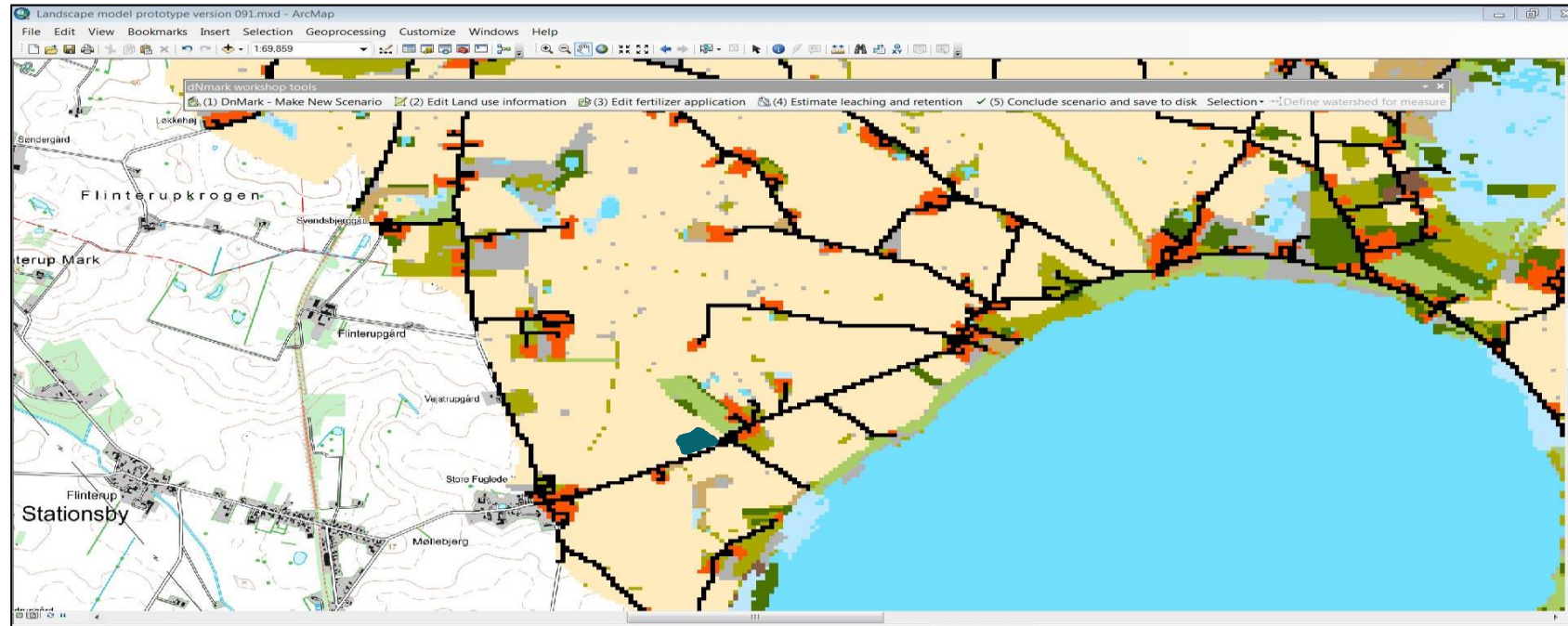
Such an additive effect overestimates effect and underestimates costs!



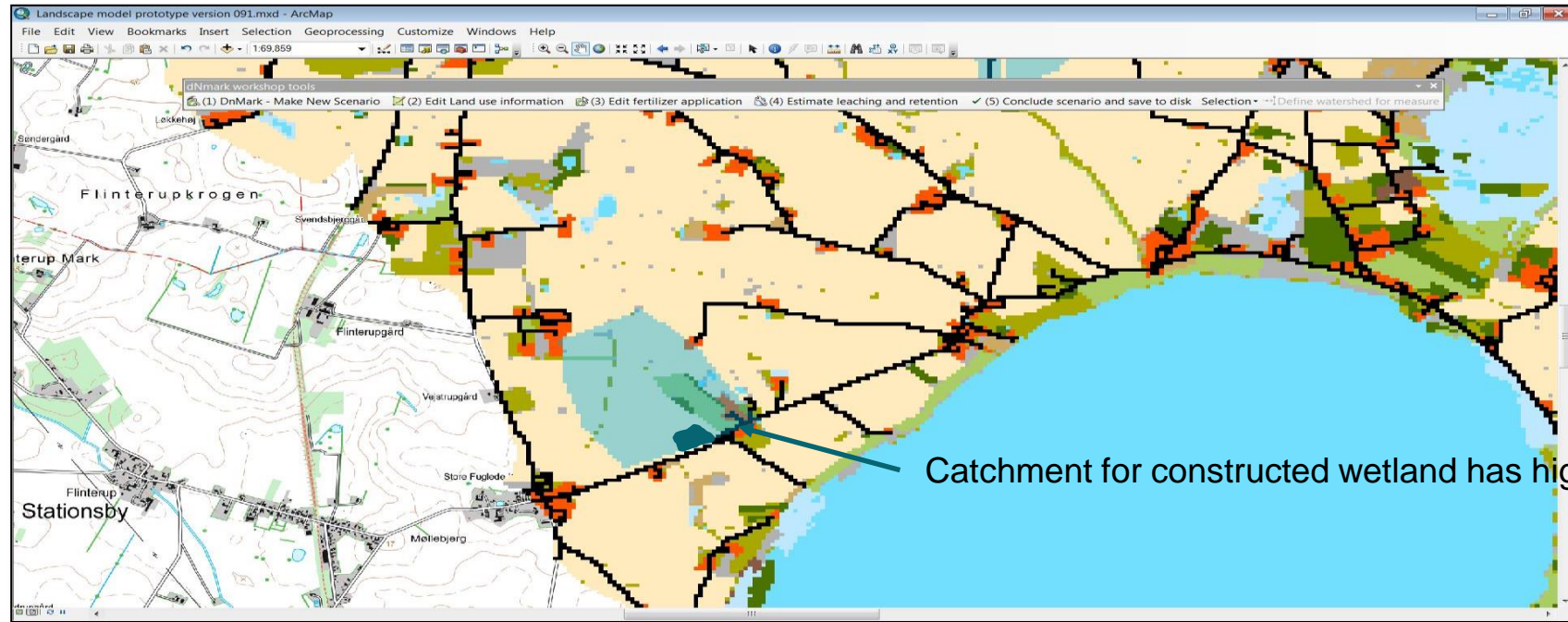
Additive or multiplicative effects – stacking measures



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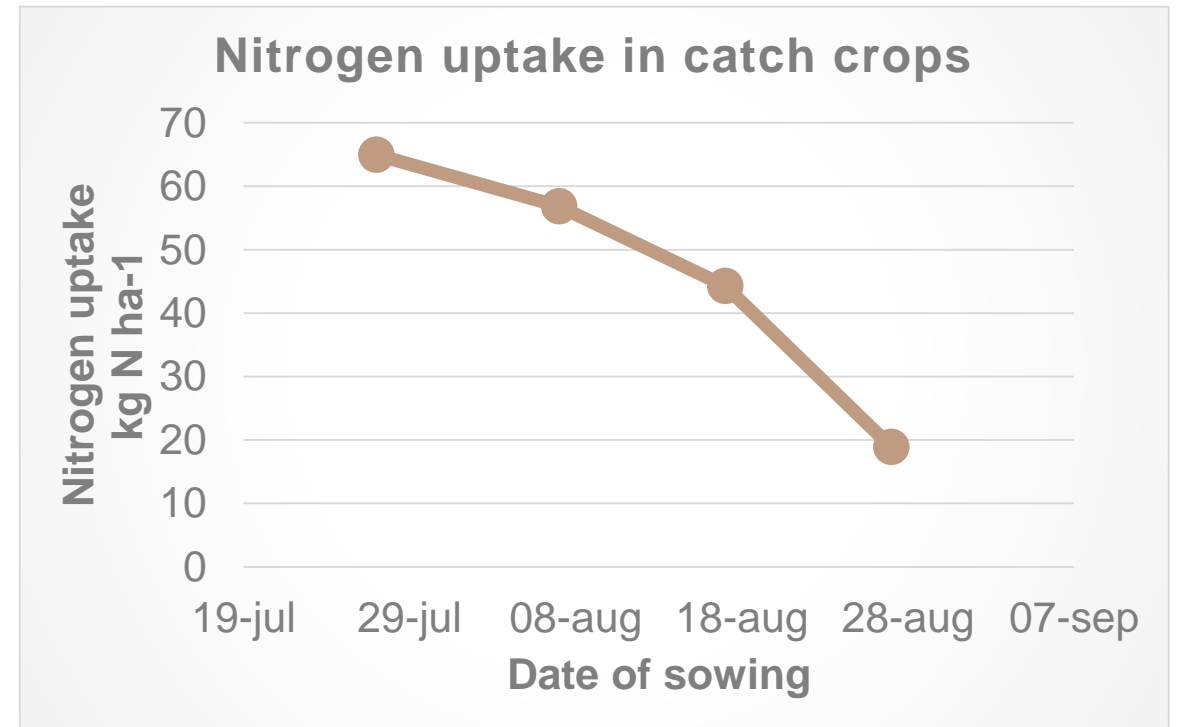


Catchment for constructed wetland has higher retention

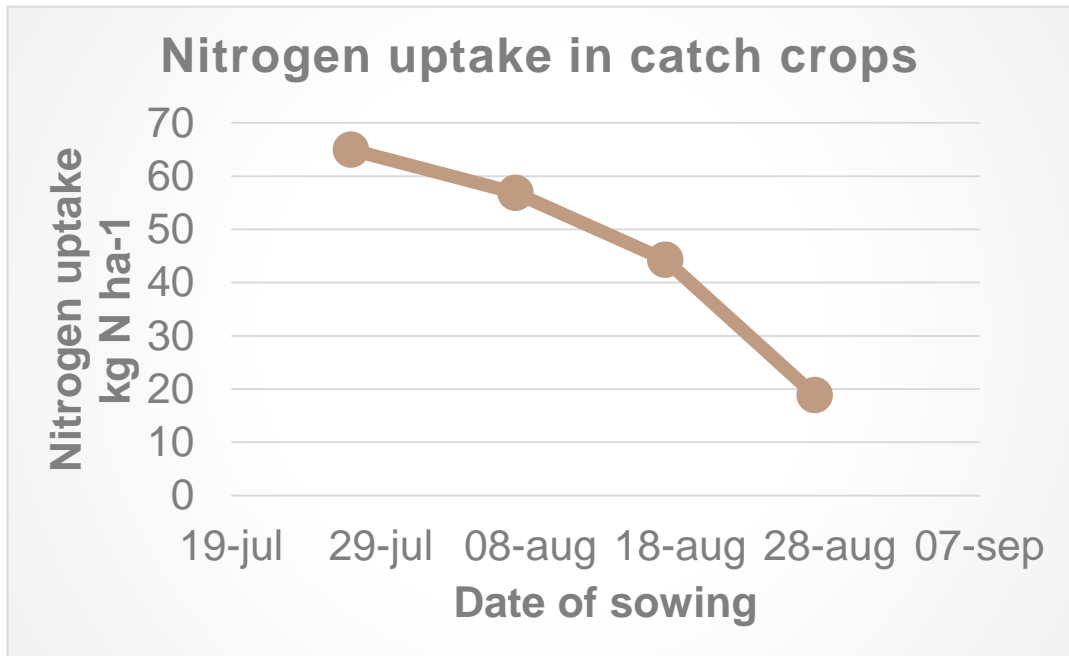
Measure	Effect on leaching (kg N ha ⁻¹)	Price (€ ha ⁻¹)	Retention (ha)	Effect after retention (ton N ha ⁻¹)	Price (€ kg N ⁻¹)
Catch crop – outside wetland catchment	25	40	40%	15	2,7
Catch crop – wetland catchment	25	40	80%	5	8

Increasing catch crop area

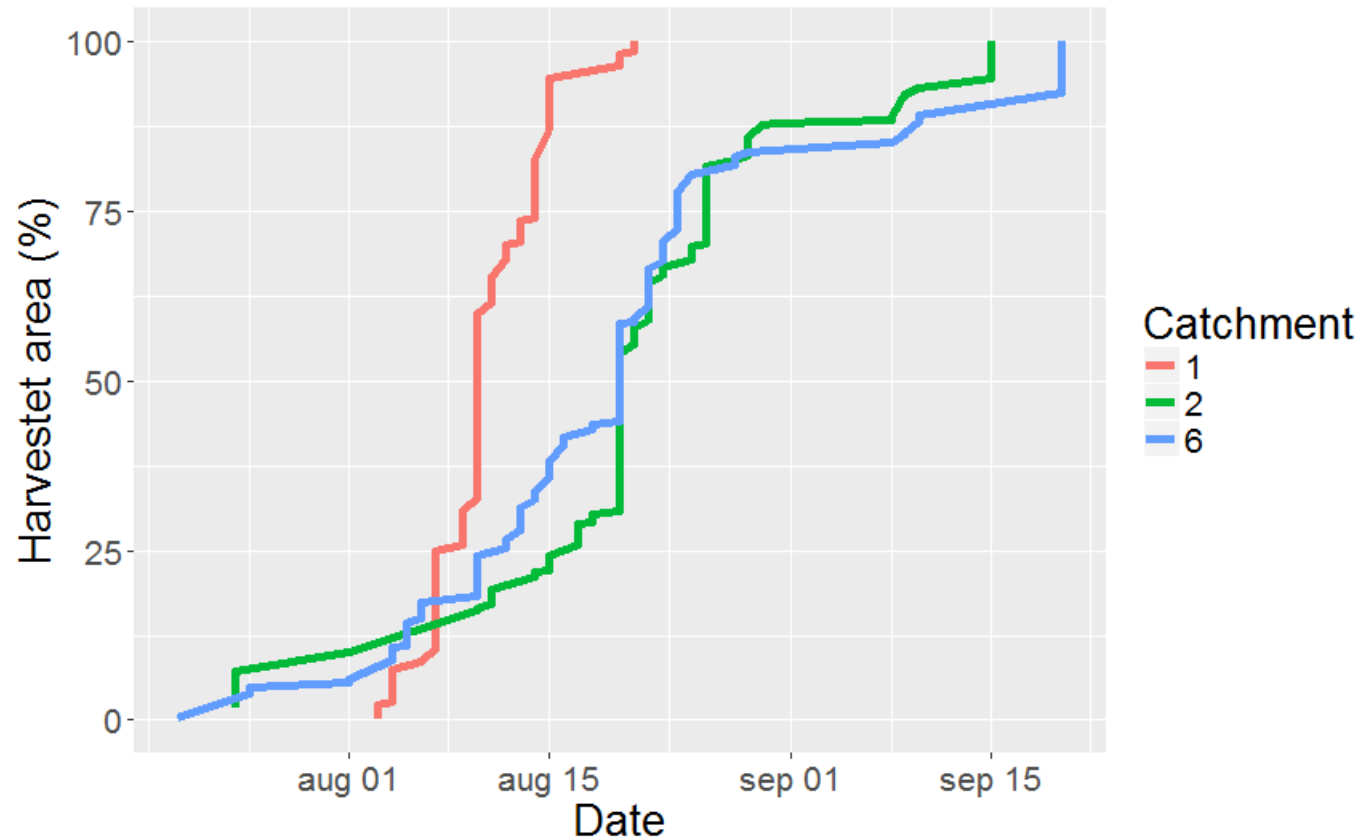
Standard effect:
1 ha of catch crops reduces leaching
25 kg N pr. ha



Space for effective catch crops



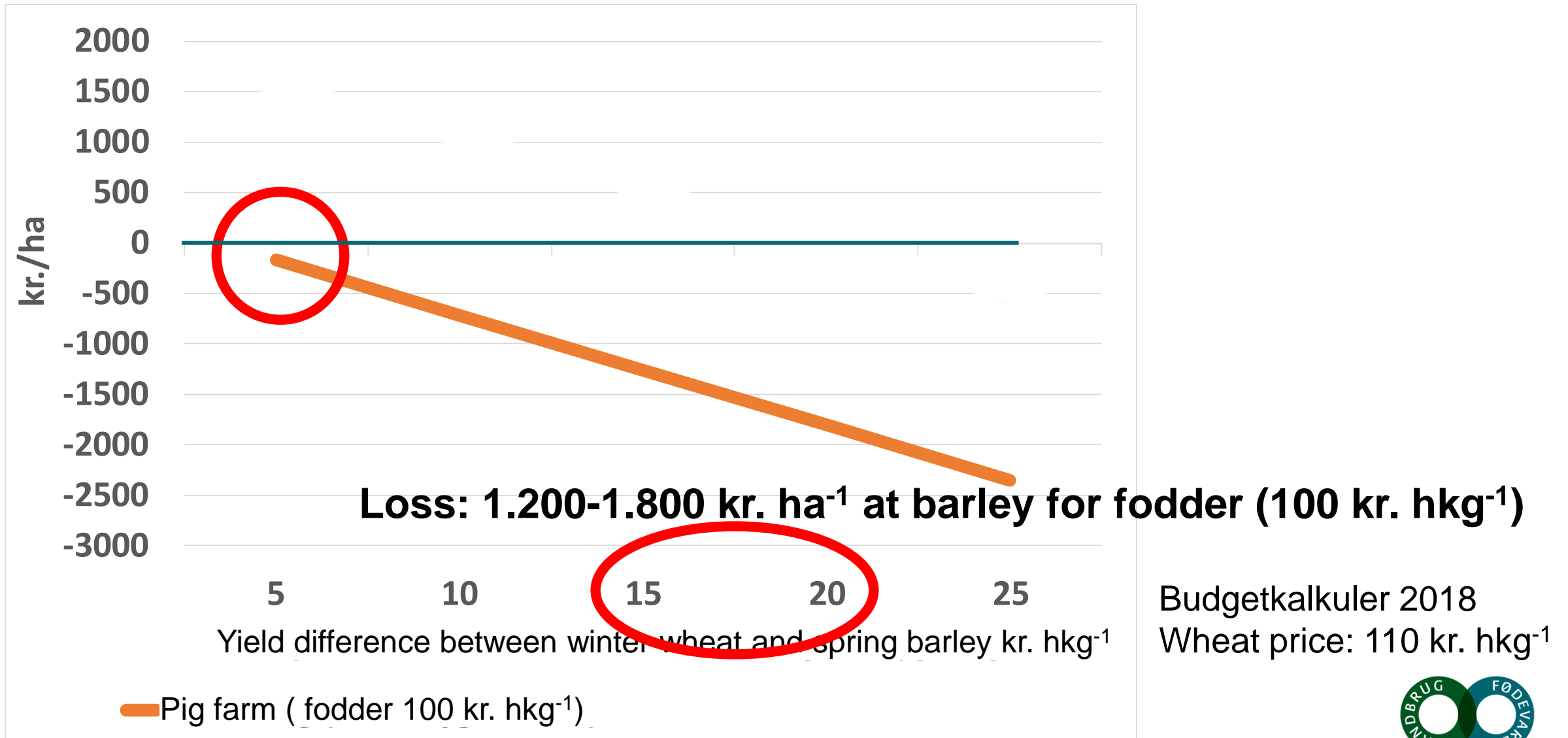
The effect of catch crops declines because they have to be sown progressively later



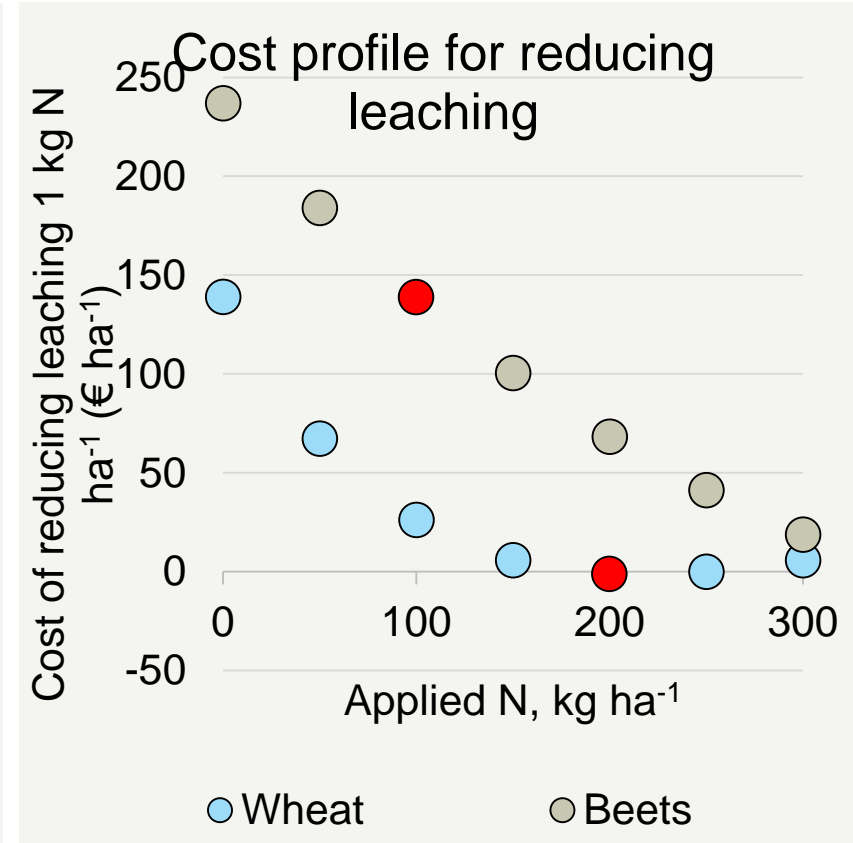
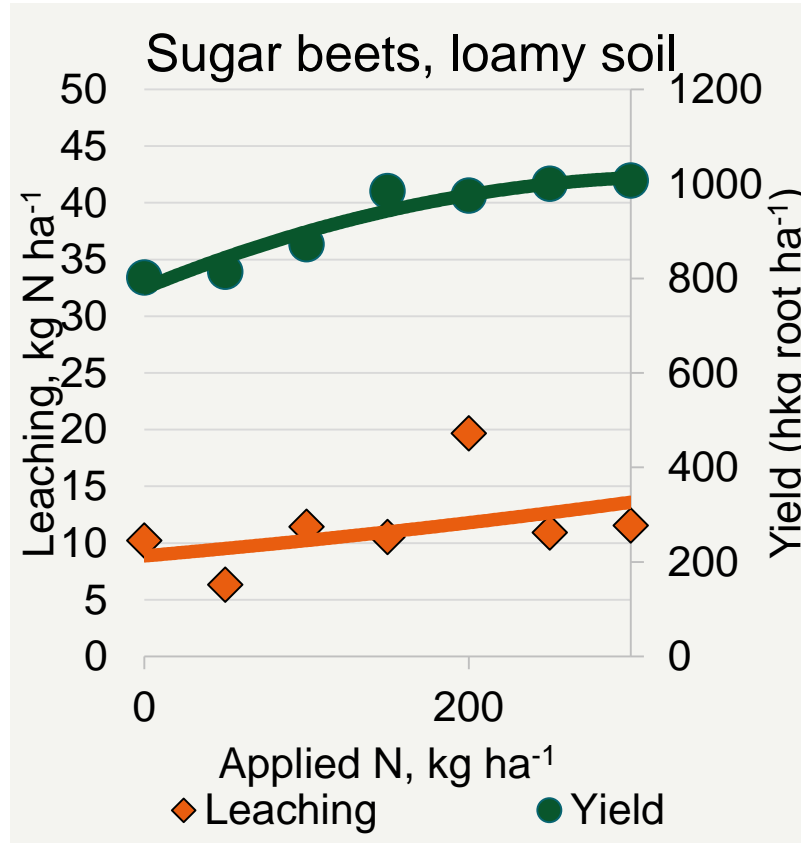
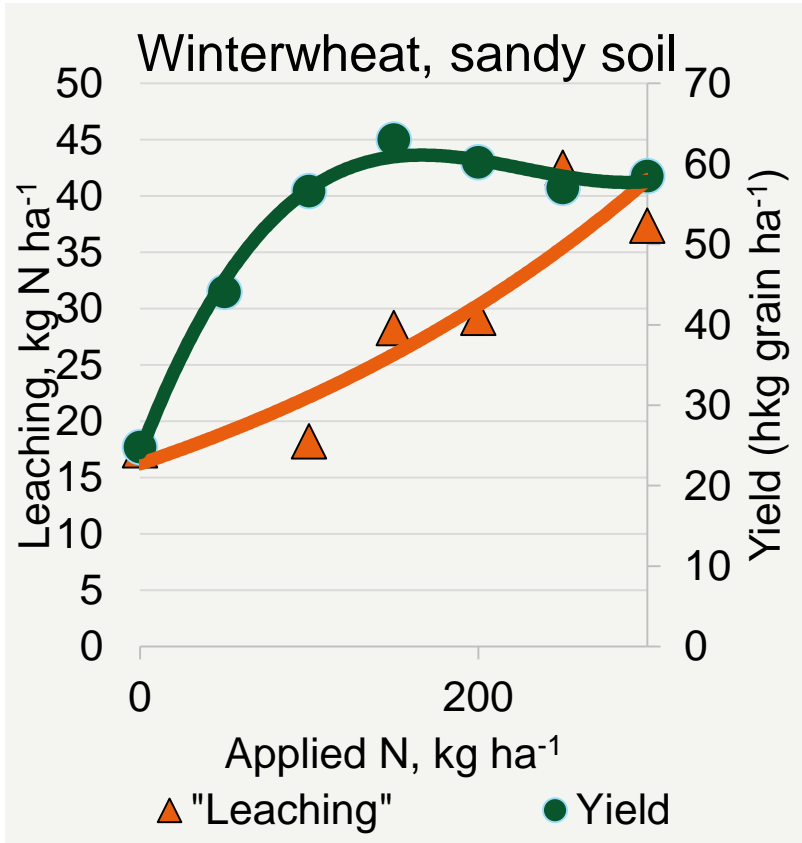
On 40% of the winter wheat is followed by winter wheat! Winter sown crops blocks space for catch crops



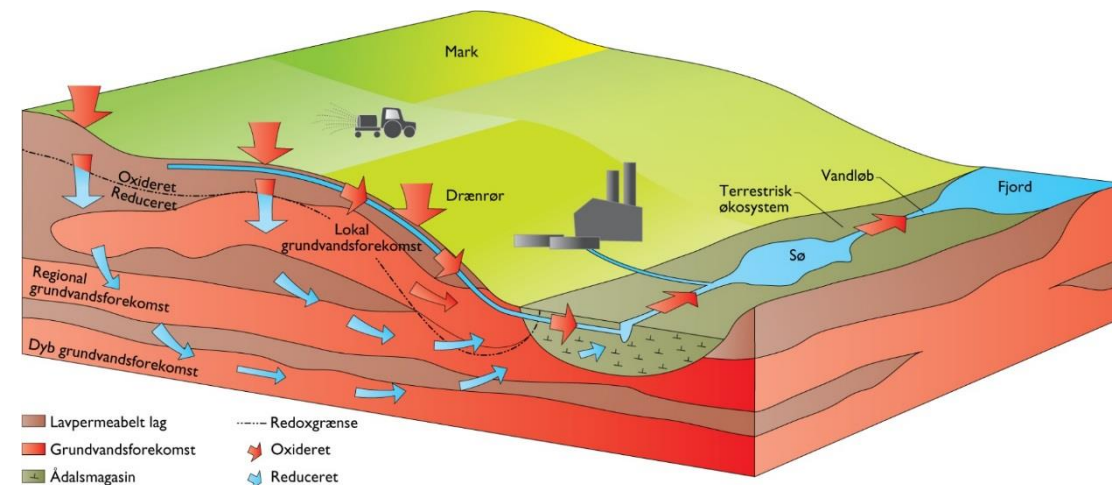
Financial cost of making room for catch crops – substituting winter wheat with spring barley



Cost of reducing nitrogen application



Conclusions



- Nitrogen measures does not stack additively, as they can affect the effectiveness of each other
- As more measures are implemented in a catchment, effect decline and cost increases
- These considerations needs to be implemented in models, if reliable effect and cost effectiveness estimates are to be achieved

Disclaimer

- My conclusions are not necessarily valid for measures that improve the nutrient utilisation efficiency or other measure that yields a financial gain
- Each measure and its interaction with other measures needs to be considered individually

