STØTTET AF

Promilleafgiftsfonden for landbrug

Nitrogen utilization on different soil types

Kristoffer Piil,

SEGES, Crop innovation

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Nutrient utilization on different soil types

- Question: Is there a difference in the maximum achievable NUE at different soil types?
- Recommended N fertilisation rates and standard yields would suggest that there is!

Normer til landbrugsafgrøder og grønsager på friland (kvælstof, fosfor og kalium)

Kvælstofnormer og retningsgivende normer for fosfor og kalium i kg pr. ha for 2019/20. Ved JB 4.1 skal du anvende N-normen for uvandet finsand, og for JB 4.2 skal du anvende N-normen for sandblandet lerjord. Normerne angiver total mængde kvælstof på årsbasis. For grønsager på friland, hvor der er fastsat en artsspecifik kvælstofnorm, gælder normen pr. kultur.

Afgrødekode	Afgrøde	Forfrugts-værdi	Indregning af forfrugtsværdi i afgrødens kvælstofnorm	Uvandet grovsand JB 1 + 3		Uvandet finsand JB 2 + 4 og 10-12		Vandet sandjord JB 1-4		Sandblandet lerjord JB 5-6		Lerjord JB 7-9		Korrektion for udbytte (salg)	Korrektion for udbytte (opfødning)	Retnings-givende normer for fosfor og kalium	
		kg N/ha	Ja/Nej	Udbytte-norm hkg/ha	Kvæl-stof-norm kg N/ha	Udbytte-norm hkg/ha	Kvæl-stof-norm kg N/ha	Udbytte-norm hkg/ha	Kvæl-stof-norm kg N/ha	Udbytte-norm hkg/ha	Kvæl-stof-norm kg N/ha	Udbytte-norm hkg/ha	Kvælstof-norm kg N/ha	kg N/hkg		kg P/ha	kg K/ha
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
11	Vinterhvede[2]	0	Ja	55 (61)	175	69 (76)	181	73 (80)	202	88 (97)	209	93 (102)	221	1,5	1,5	19	71
13	Vinterhvede, brødhvede[2]	0	Ja	55 (61)	212	69 (76)	221	73 (80)	243	88 (97)	252	93 (102)	266	1,7	0,0	21	67
57	Vinterrhavre	0	Ja	51 (56)	143	65 (72)	144	64 (70)	158	77 (85)	159	81 (89)	168	1,2	1,2	18	53
14	Vinterrug[2]	0	Ja	51 (56)	143	65 (72)	144	64 (70)	158	77 (85)	159	81 (89)	168	1,2	1,2	18	53

Analysis of NUE in winter wheat and spring barley

	Winter wheat	Spring barley
Total no. of trials	1049	626
Periode	1987	2018
Typical N rates	0-250 kg N ha^{-1} (300, since 2015)	0-200 kg N ha^{-1}
Increments	50 kg N ha^{-1}	40 kg N ha^{-1}

N yield in grain measured = Yes
Previous crop = Wheat, barley, rye or triticale
Financially optimal nitrogen application rate >50 kg N ha-1
Soil mineral nitrogen content in spring < 50 kg N ha-1
Soil type had been determined by measurement (0-25 cm depth)
Number of trials carried out on same soil type >10

Leaves 351 winter wheat trials and 155 spring barley trials

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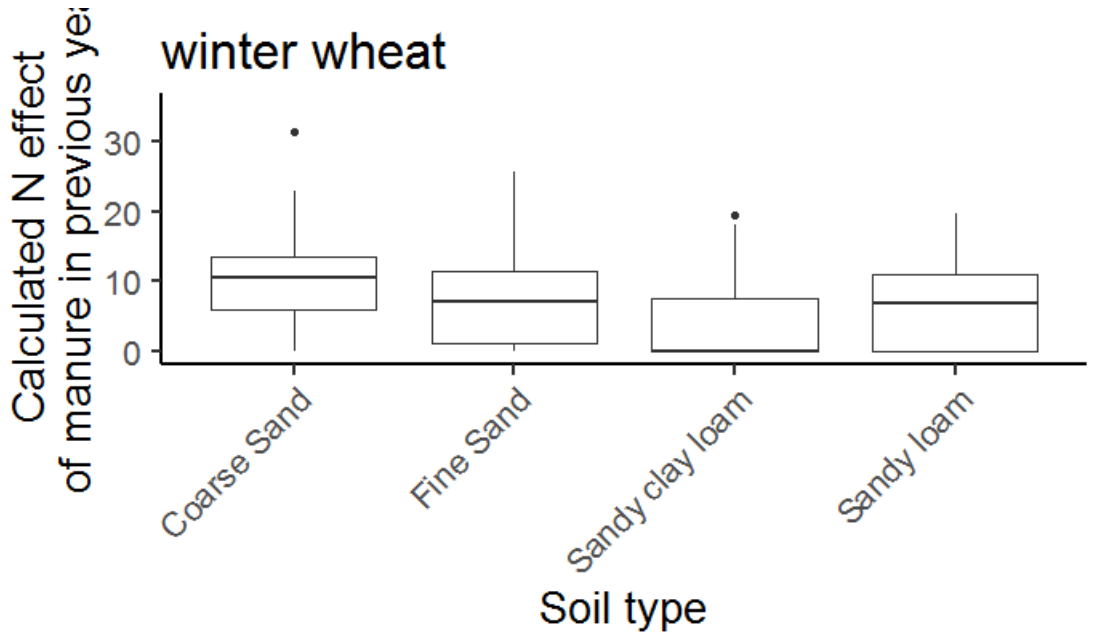
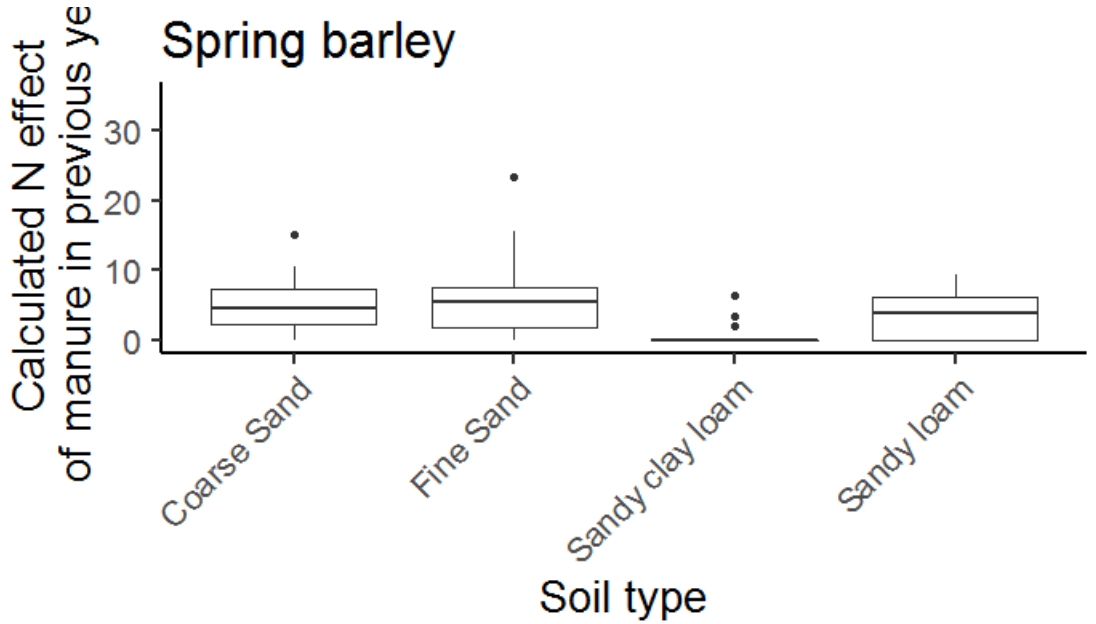
N from previous years manure fertilisation

	Pig slurry % of TN mineralized	Cattle slurry % of TN mineralized
1st year	4	6
2nd year	2	3
3rd year	2	2
4th year	1	2
5th year	1	2
Total	10	15





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Distribution of trials on soil types

	Coarse sand	Fine sand	Sandy loam	Sandy clay loam	Clay	Organic	Total
Winter wheat	28	63	148	112	0	0	351
Spring barley	50	45	38	22	0	0	155

- Coarse and fine sand: <10% clay
- Sandy loam: 10 – 15% clay
- Sandy clay loam 15 – 45% clay (very rarely >25%)

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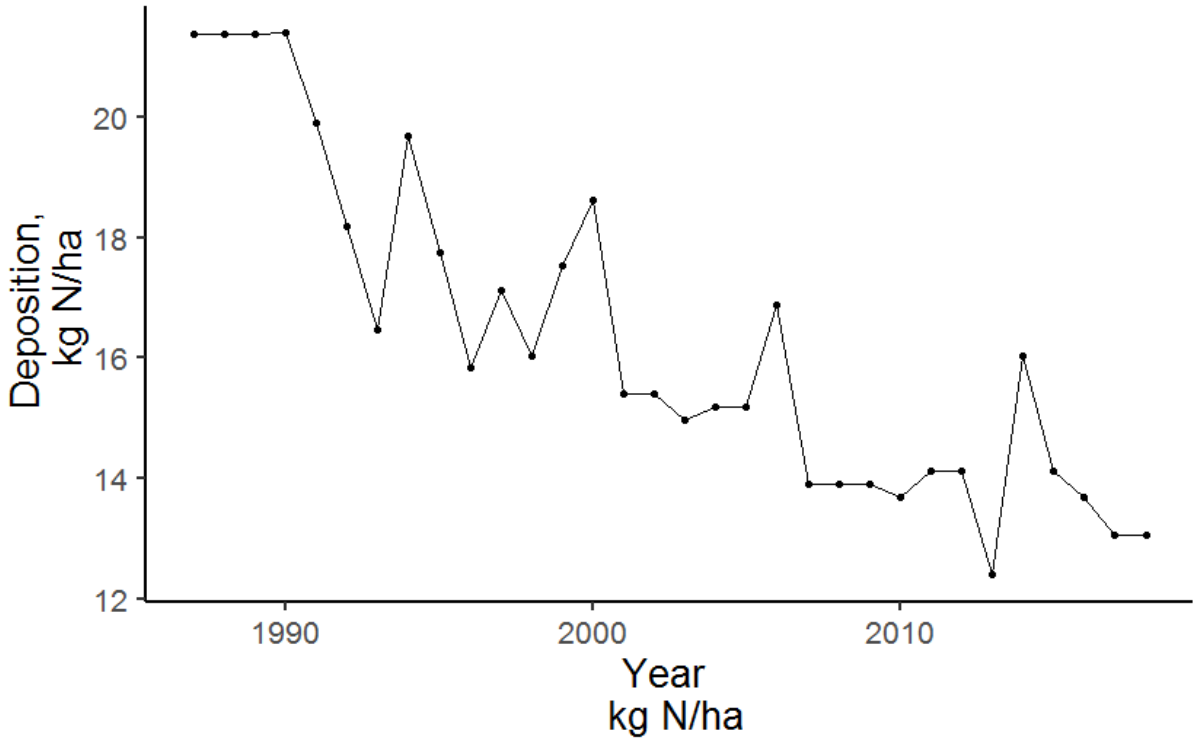
NUE calculation

$$NUE = \frac{Harvested\ N}{N\ applied + N\ deposition + N\ seedgrain}$$



Redrawn form Ellermann (2019)

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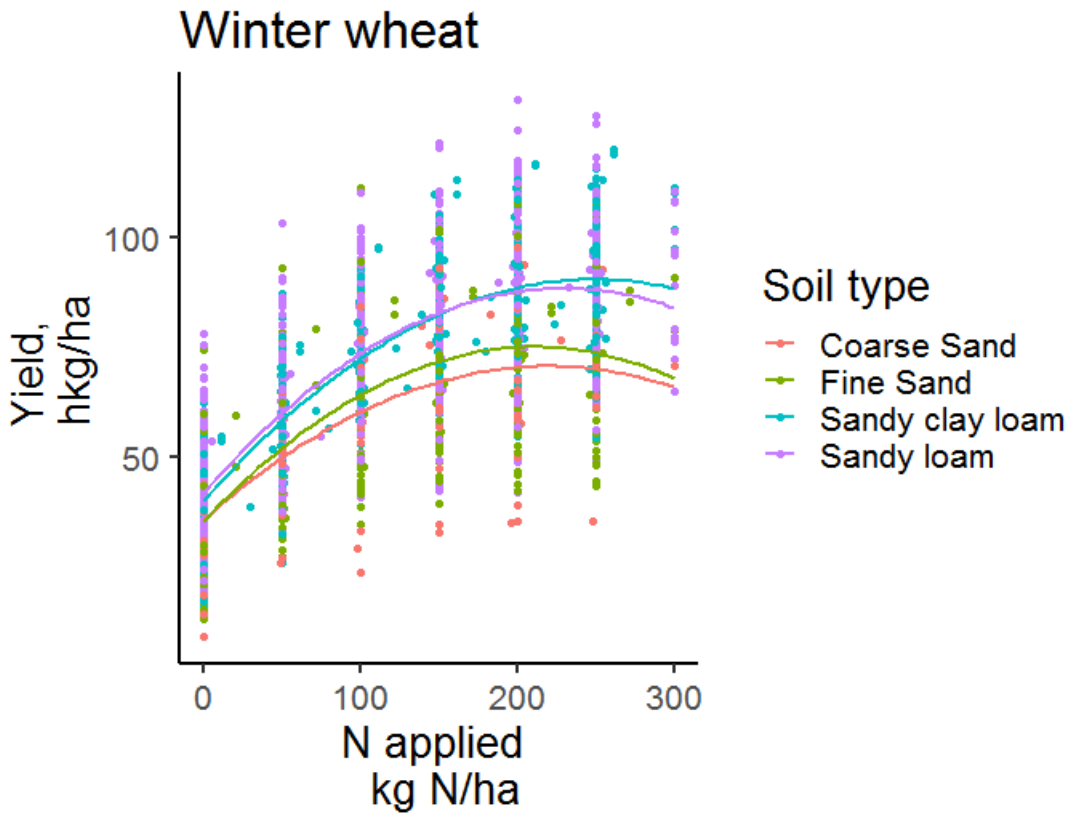
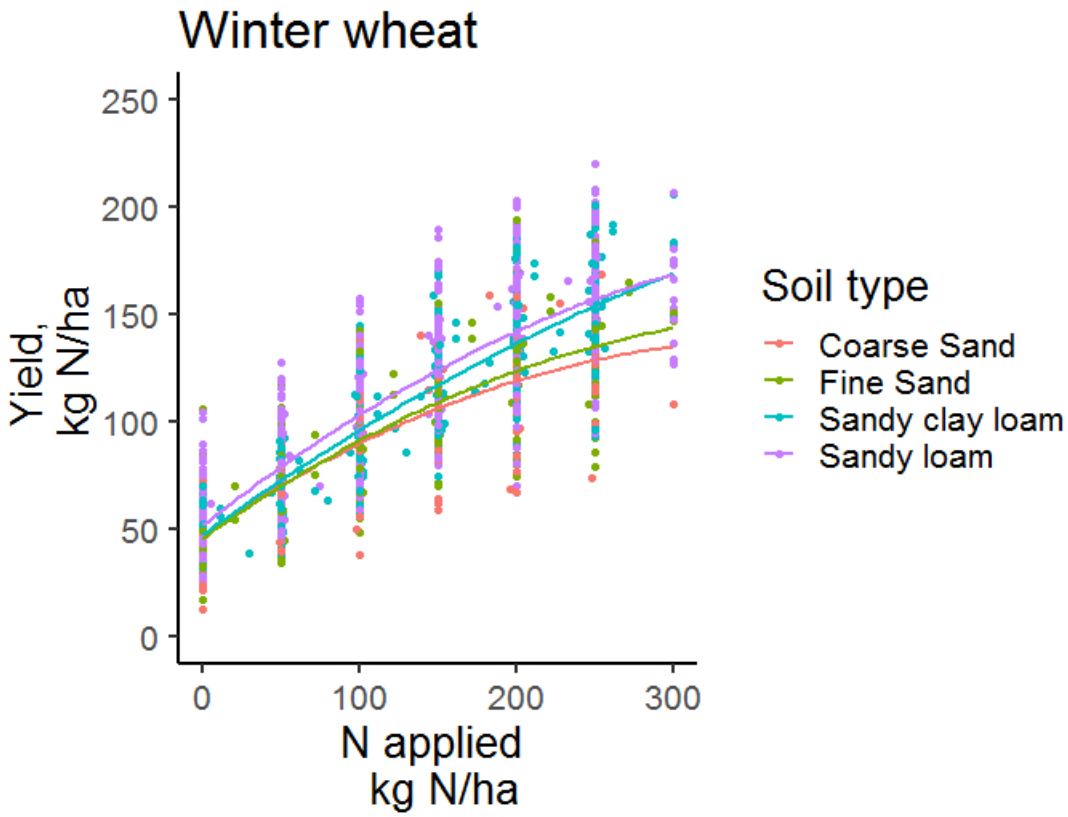
Yields, winter wheat





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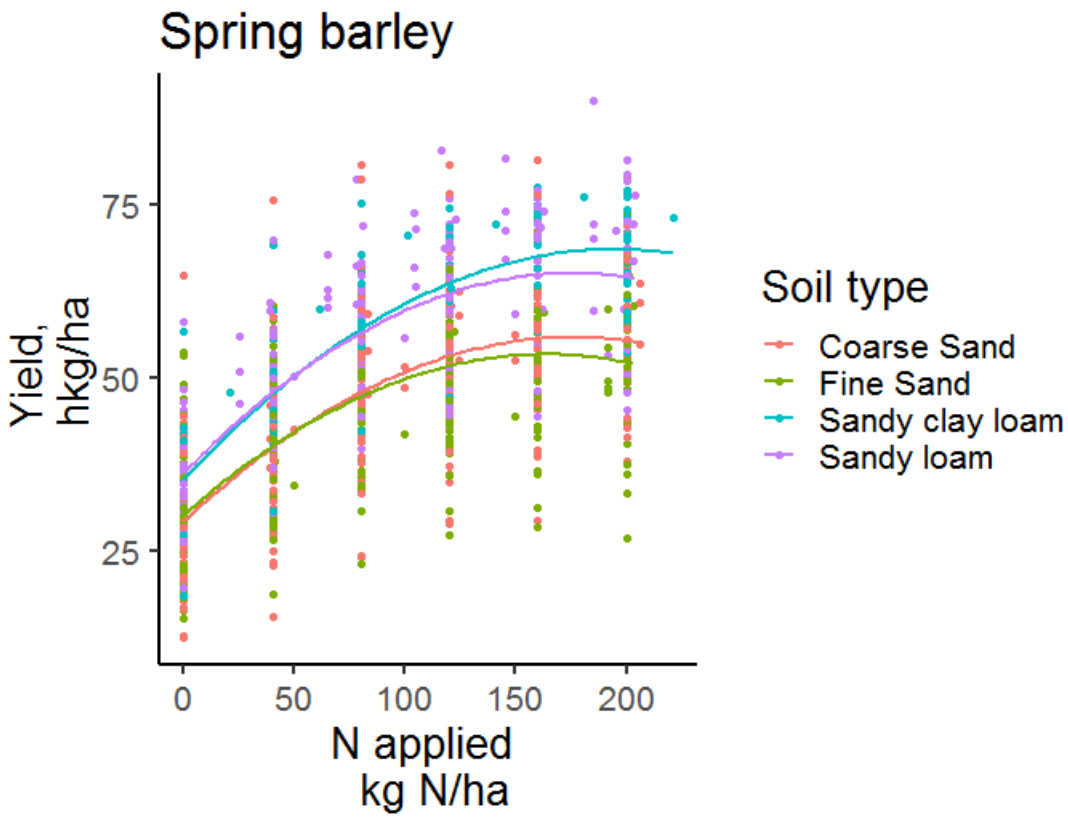
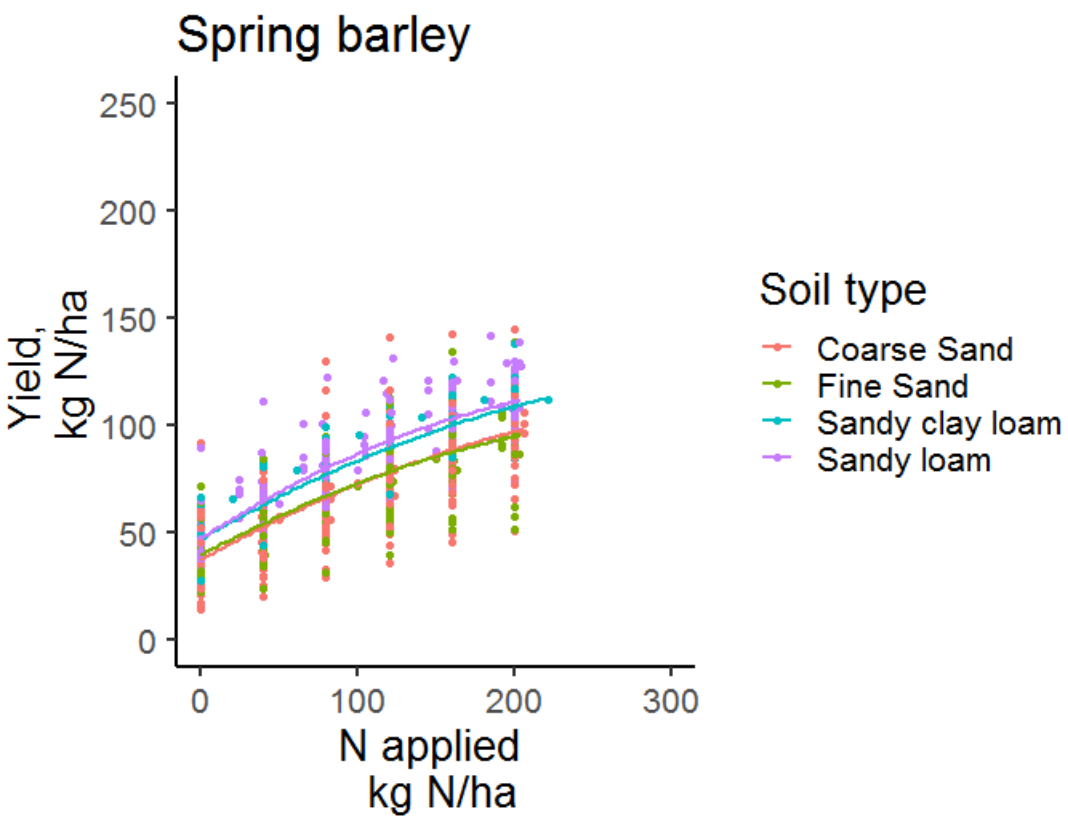
Yields, spring barley





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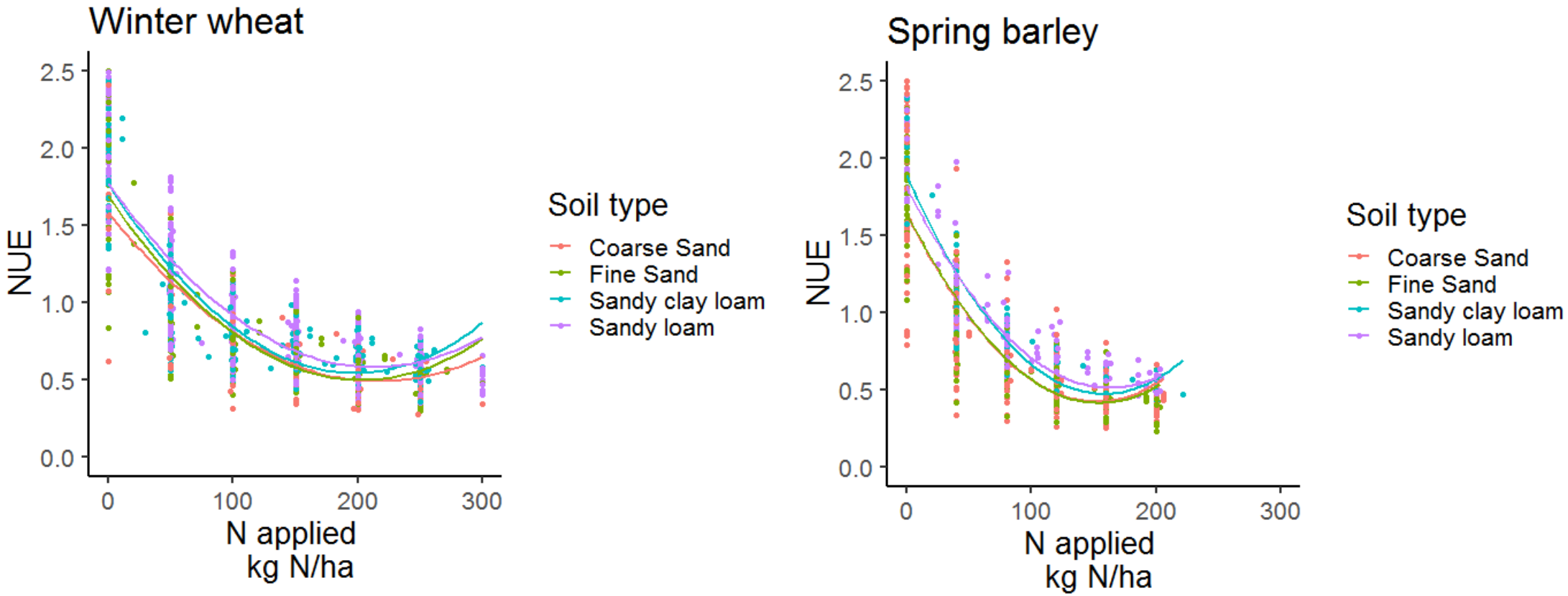
NUE


Winter wheat
NUE
2.5
2.0
1.5
1.0
0.5
0.0
0
100
200
300
N applied
kg N/ha
Soil type
Coarse Sand
Fine Sand
Sandy clay loam
Sandy loam
Spring barley
NUE
2.5
2.0
1.5
1.0
0.5
0.0
0
100
200
300
N applied
kg N/ha
Soil type
Coarse Sand
Fine Sand
Sandy clay loam
Sandy loam

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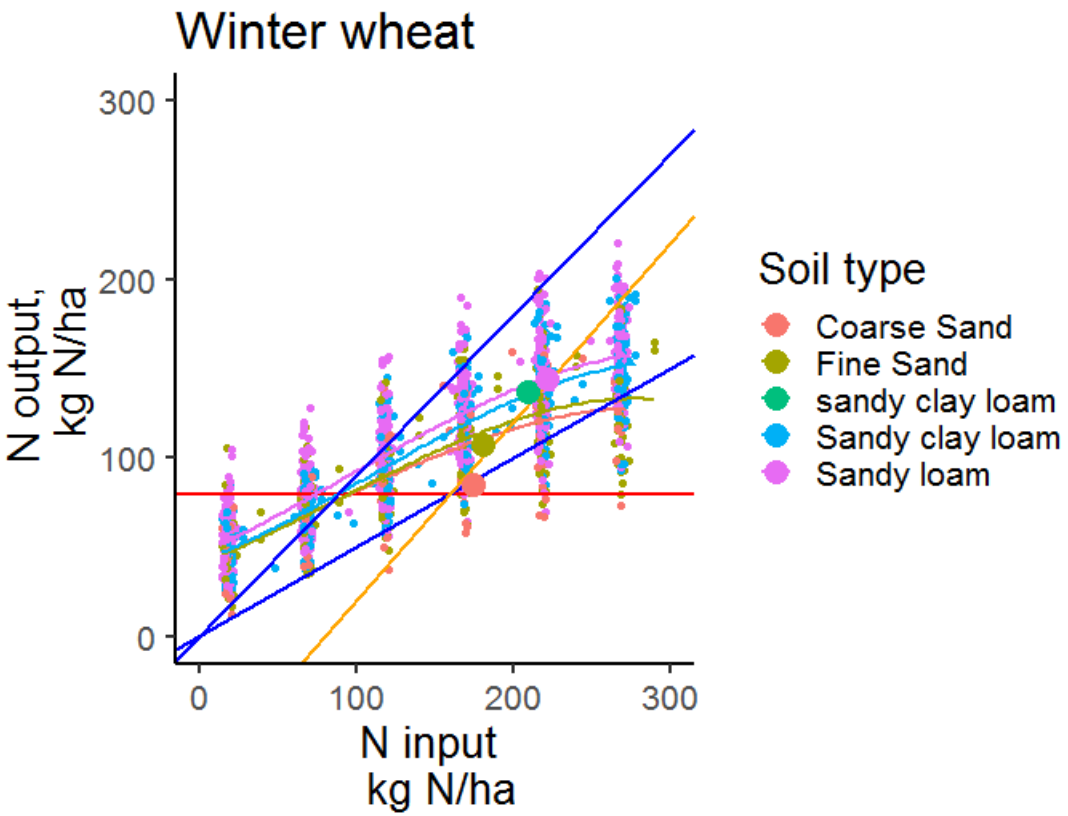
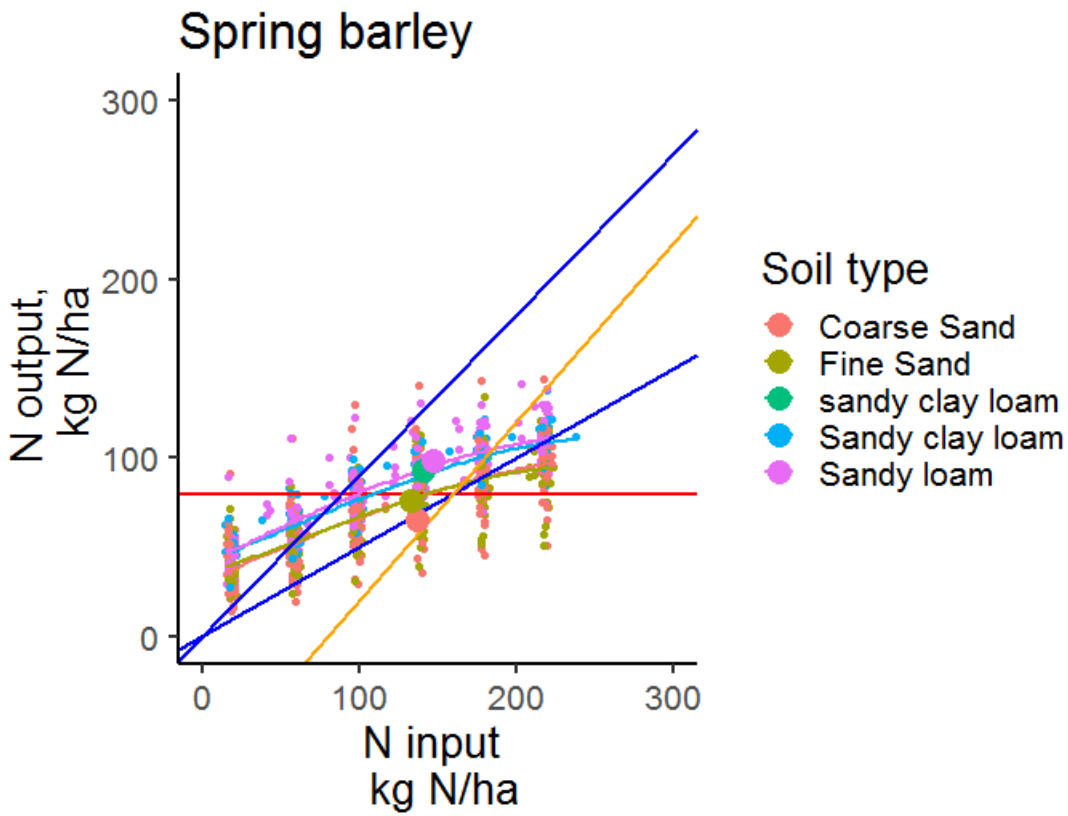
NUE


Winter wheat
N output, kg N/ha
300
200
100
0
0
100
200
300
N input kg N/ha
Soil type
Coarse Sand
Fine Sand
sandy clay loam
Sandy clay loam
Sandy loam


Spring barley
N output, kg N/ha
300
200
100
0
0
100
200
300
N input kg N/ha
Soil type
Coarse Sand
Fine Sand
sandy clay loam
Sandy clay loam
Sandy loam

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Statistical analysis

NUE ~Soil type + (1|Year)

	Winter wheat, 190-210 kg N ha^{-1}	Spring barley, 140-160 kg N ha^{-1}
Coarse sand	0.55 a	0.49 a
Fine sand	0.58 a	0.50 a
Sandy loam	0.66 b	0.58 b
Sandy clay loam	0.65 b	0.57 b

NUE.recommended rate ~Soil type + (1|Year)

	Winter wheat	Spring barley[1]
Coarse sand	0.52 a	0.49 a
Fine sand	0.59 ab	0.56 b
Sandy loam	0.63 b	0.62 b
Sandy clay loam	0.59 ab	0.58 b

[1]Model residuals for both fixed and random factor does not fulfil the assumption of normality

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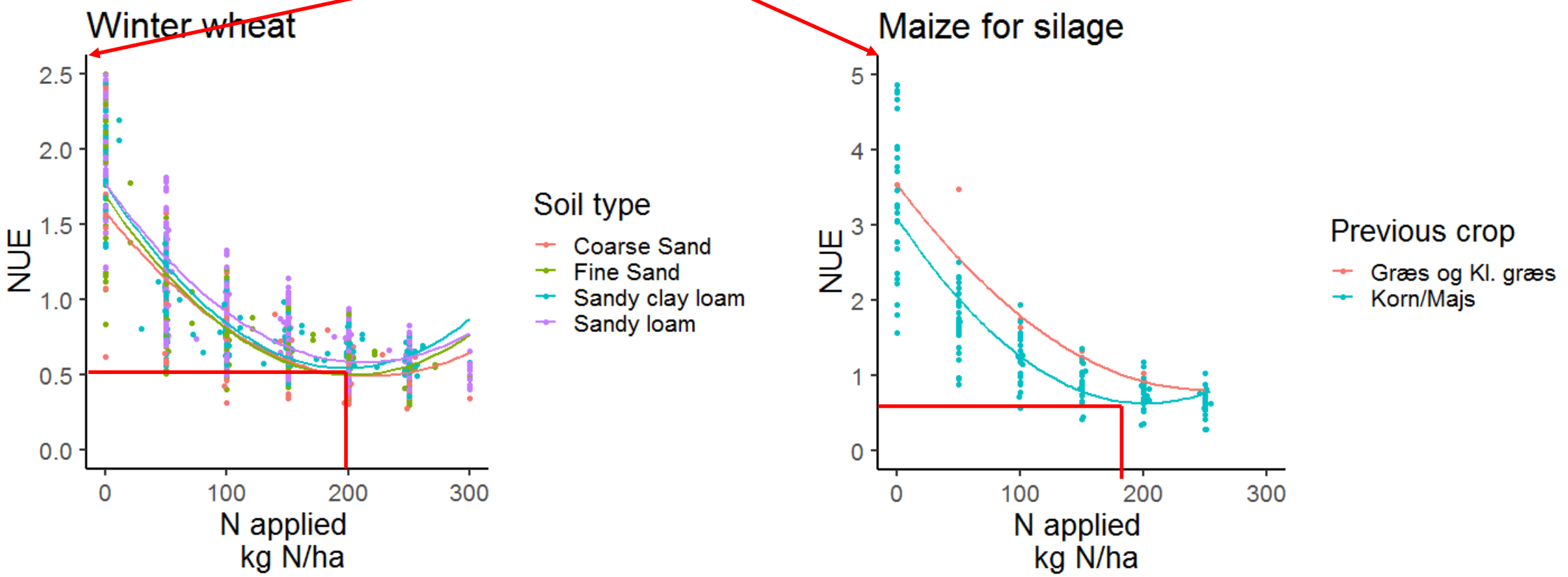
NUE

Different scales



NUE, 190 – 210 kg N ha^{-1} = 0,57

NUE, 165 – 200 kg N ha^{-1} = 0,78

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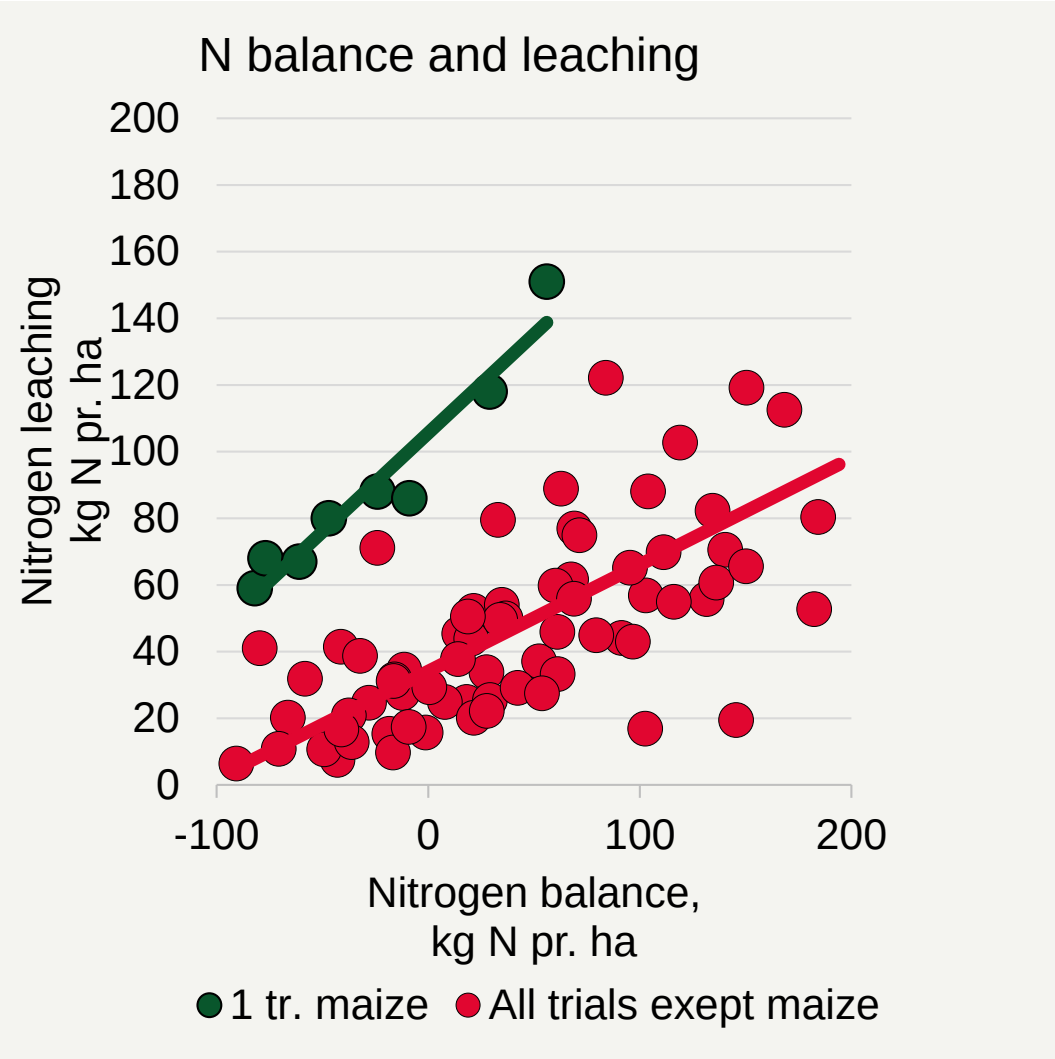
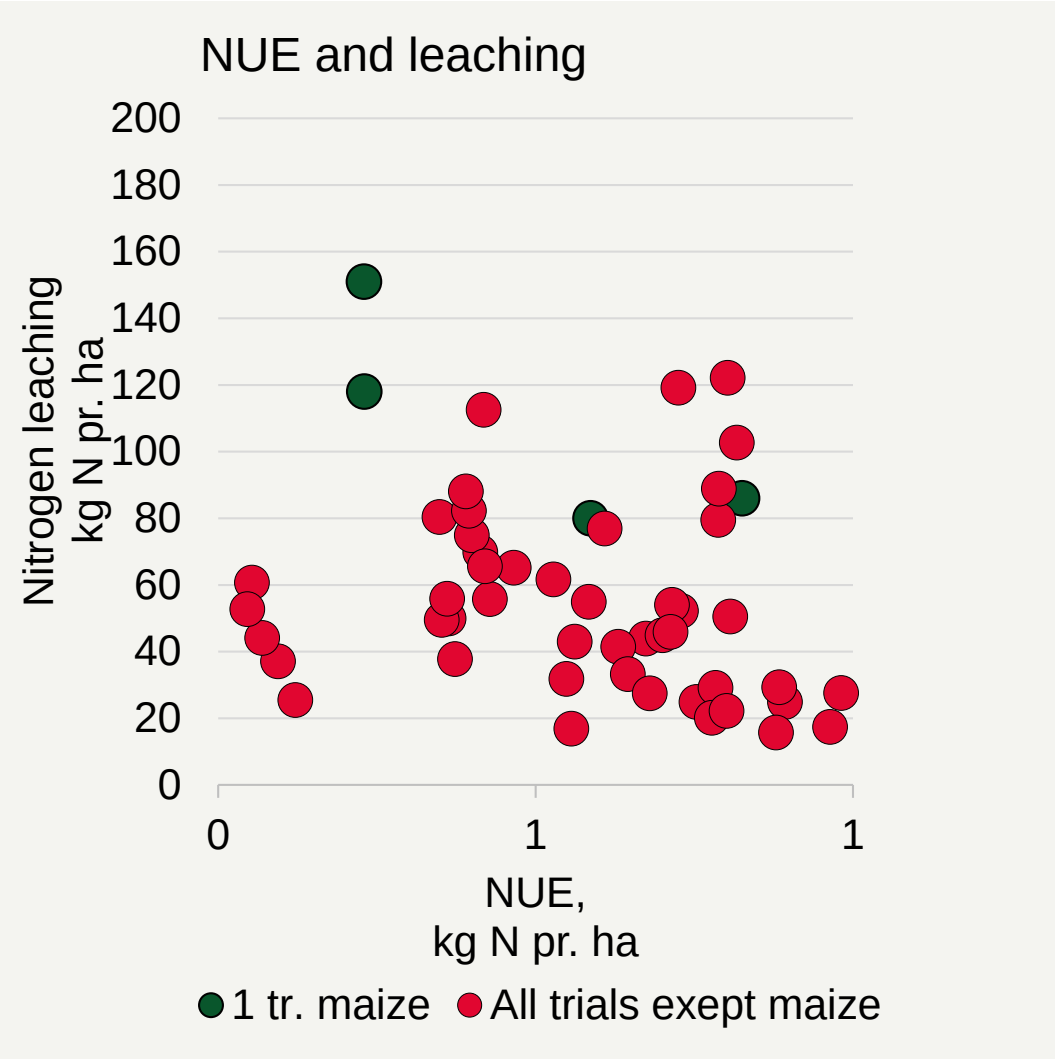
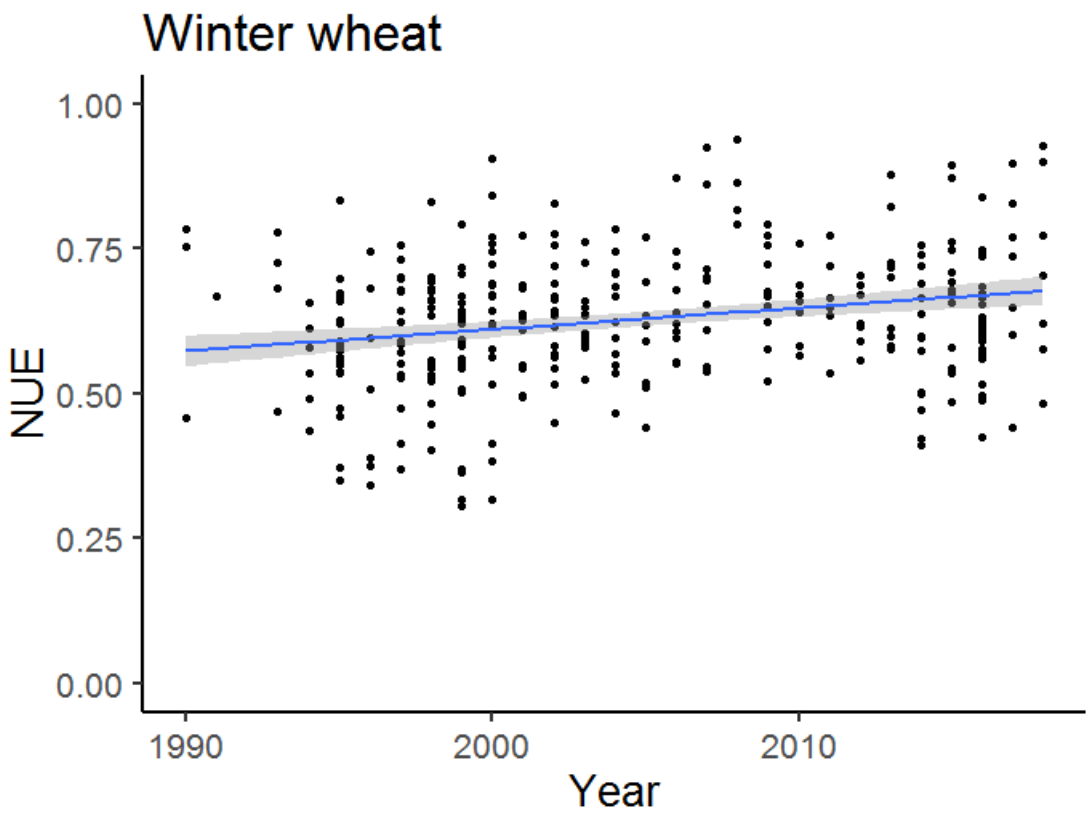
NUE, balance and leaching

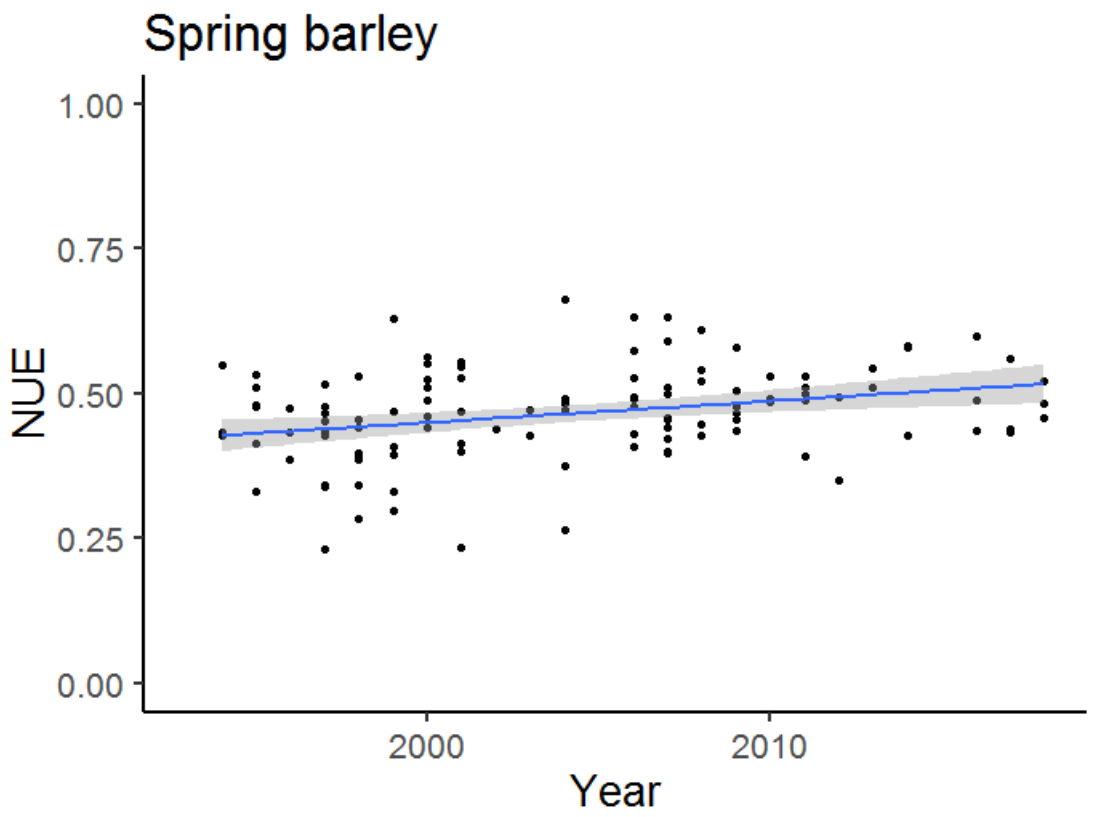




NUE over time



Slope = 0.0037 yr^{-1}, p< 0,001



Slope = 0.0037 yr^{-1}, p< 0,002

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Conclusion

- Question: Is there a difference in the maximum achievable NUE at different soil types?
- Answer: Yes, NUE is lower at sandy soils than at loamy soils
- Additional findings:
  - NUE increase over the years.
  - Much of Danish grain production is not within the defined operating space

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