Short introduction into fertilizer law and voluntary agreements in water protection areas

Motivation and legal background for the field trials in Lower Saxony, Germany

15th of November 2023
Fertilisation Authority of Lower-Saxony
Wolfgang Klahsen

The trials are funded by the Lower Saxony Ministry for the Environment, Energy and Climate Protection (MU) from funds from the water abstraction charge and the sovereign tasks in the area of fertiliser law by the Ministry of Food, Agriculture and Consumer Protection.

The Lower Saxony Chamber of Agriculture – a brief overview

Landwirtschaftskammer Niedersachsen
Düngebehörde

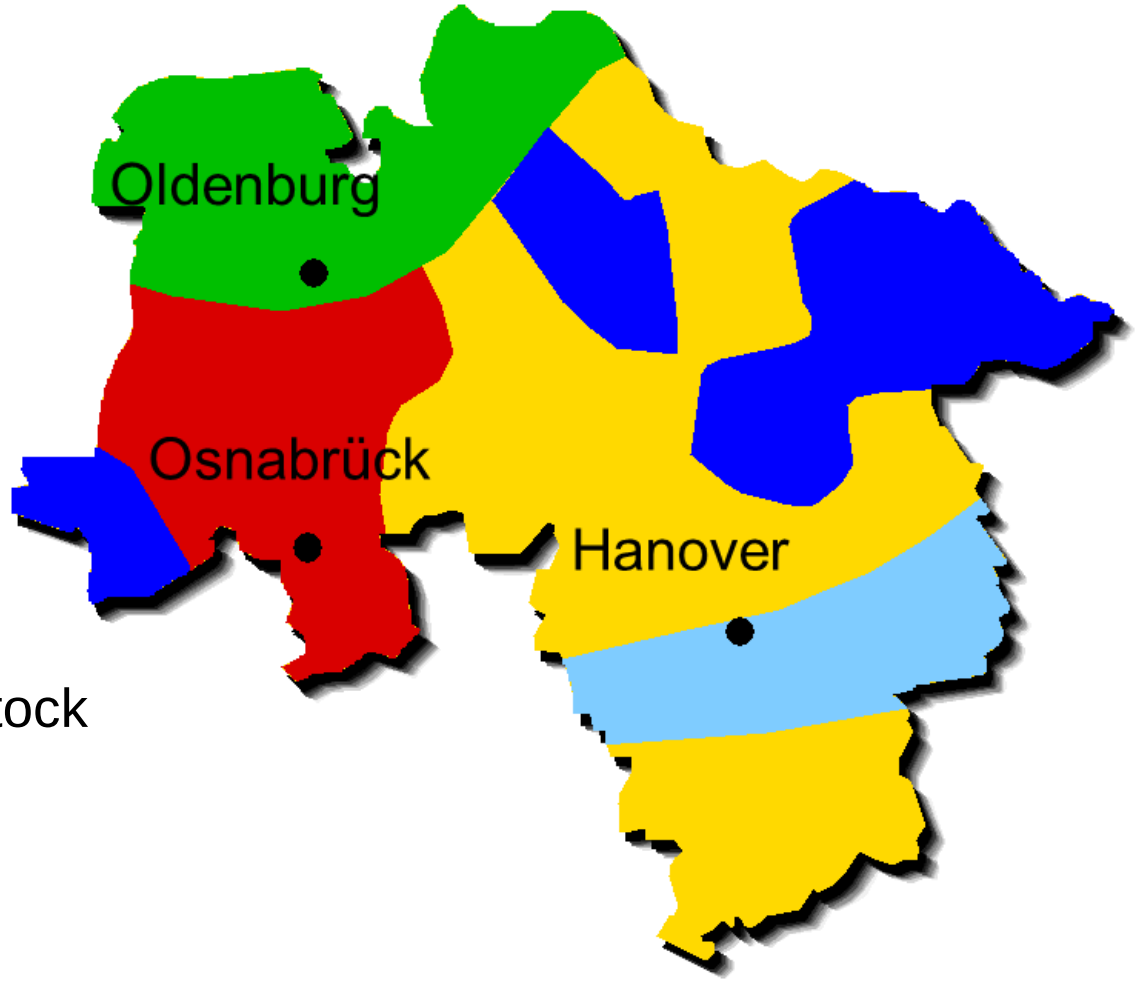
- Self-governing organisation of agriculture in Lower Saxony
- Represents the professional interests of employers and employees in agriculture, forestry and horticulture
- 2.400 employees
- Area covered: 2.6 million ha of agricultural land and 700,000 ha of private forests
- Most important tasks: Counselling as well as education, training and further education of employees and employers in agriculture and forestry.
- In addition, execution of sovereign tasks, including the implementation of laws and ordinances, for example in fertiliser law

Landwirtschaftskammer Niedersachsen
Düngebehörde

Regional focus of Agriculture in Lower Saxony

Main activity

- livestock farming
- grassland farming
- wheat cultivation
- potato cultivation
- No particular main activity in livestock farming/agriculture



Nutrient accumulation in Lower Saxony

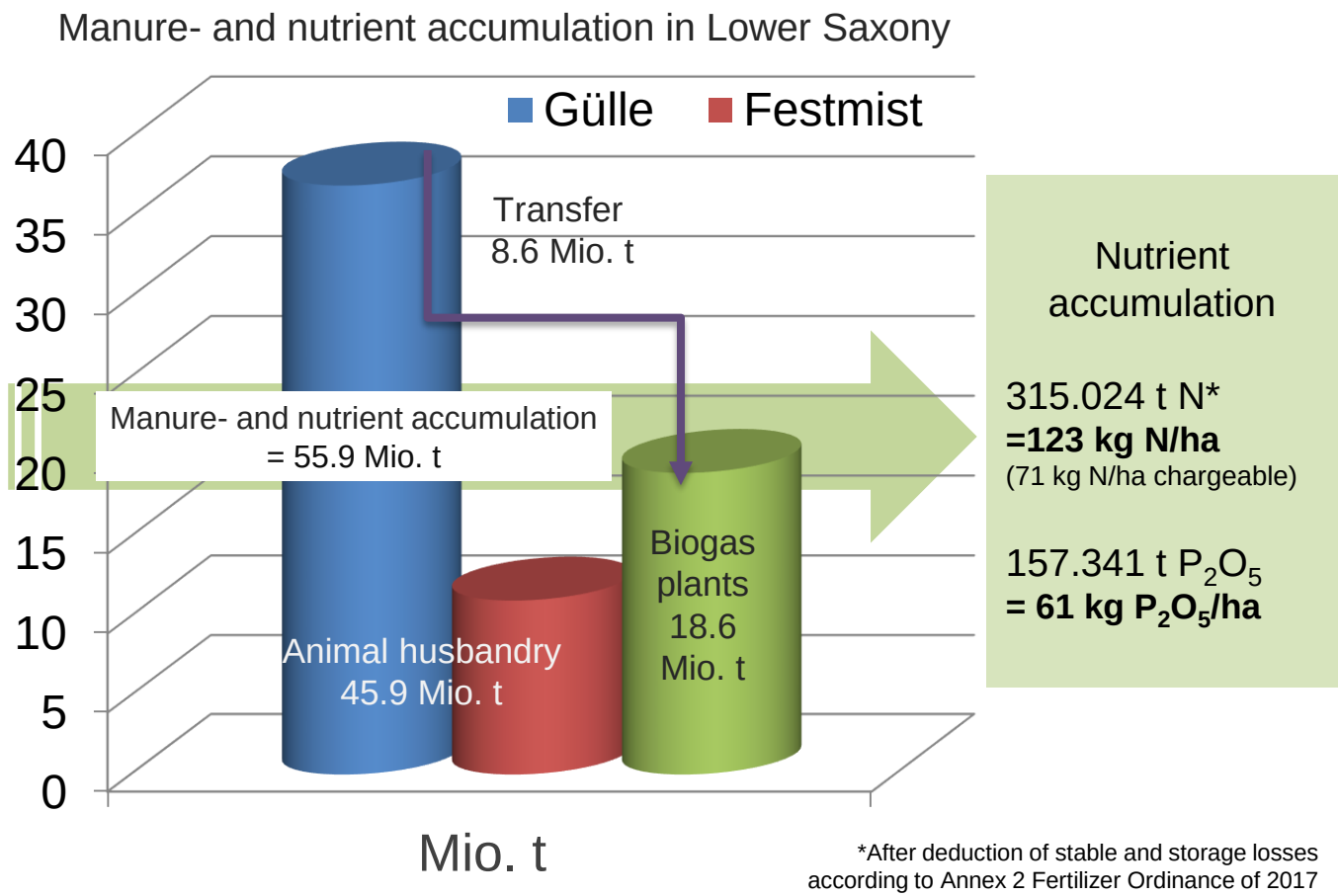
Landwirtschaftskammer Niedersachsen
Düngebehörde

Animal count

2.4 Mio.

10.6 Mio.

103.3 Mio.



Nutrient accumulation

315.024 t N*
=123 kg N/ha
(71 kg N/ha chargeable)

157.341 t P_2O_5
= 61 kg P_2O_5/ha

*After deduction of stable and storage losses according to Annex 2 Fertilizer Ordinance of 2017

Fertiliser Ordinance – Federal and state level

Landwirtschaftskammer Niedersachsen
Düngebehörde

Fertiliser Regulation
Federal government
(DüMV)

Manure Transfer Regulation
Federal government and states

Fertiliser Ordinance (DüV)

Regulates: Good professional practice in fertilising

Valid for: farms that cultivate and fertilise land

Lower Saxony Fertiliser Ordinance (NDüngGewNPVO)

Lower Saxony Ordinance on Reporting Obligations with regard to farm manure (NDüngMeldVO)

Landwirtschaftskammer Niedersachsen
ENNI Niedersachsen

German Fertiliser Act (DüngG)

Regulates: Principles of good practice in fertilising and putting fertilisers into circulation.
Authorizing basis for: far-reaching regulations of the federal government and the states

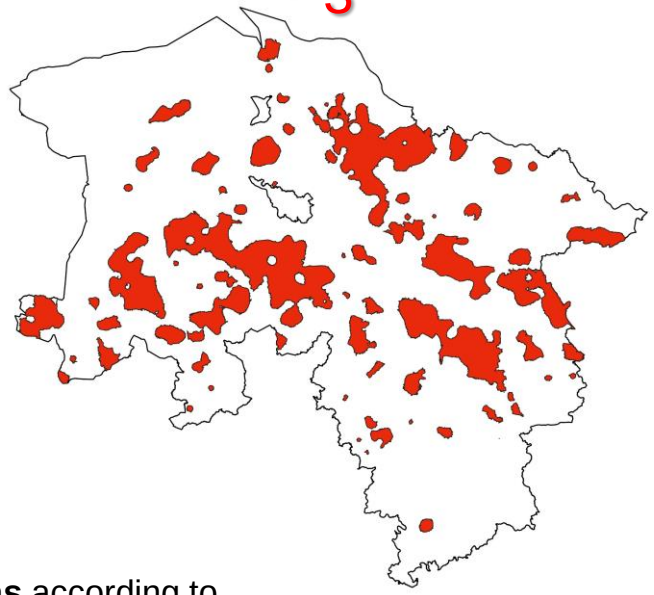
Red Areas and Water Catchment Areas in Lower Saxony

Landwirtschaftskammer Niedersachsen
Düngebehörde

Fertilizer Ordinance
Federal government
(DüV)

Red areas

NO_3



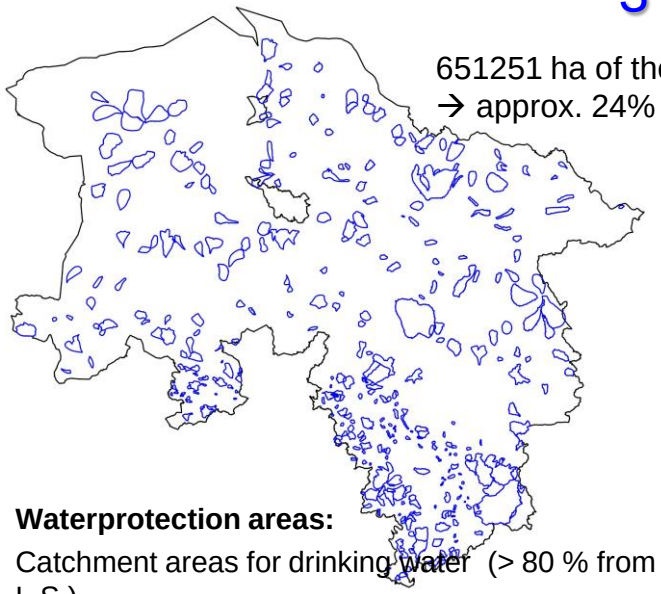
Nitrate-polluted areas according to

General administrative regulation for the designation of areas polluted with nitrates and eutrophic areas (AVV GeA)

551435 ha of the state area
→ 21% of the agriculturally used area

Waterprotection areas

NO_3



651251 ha of the state area
→ approx. 24% of the agriculturally used area

Waterprotection areas:
Catchment areas for drinking water (> 80 % from groundwater in L.S.)

Special Voluntary Agreements:

e.g.: Special bonus for a low level of residual nitrogen in the soil after growing silage maize

e.g.: After Harvesting/Autumn: **Basic Value 70 kg Nmin/ha** (0-90 cm deepth);

6 Euro per kilogram reduced Nmin/ha below this basic value (maximum 320 Euro/ha) residual Nitrogen <20 kg Nmin/ha

Financed by a water abstraction charge

State-wide tasks in co-operative drinking water protection § 28 NWG

Landwirtschaftskammer Niedersachsen
Düngebehörde

financed by the Lower Saxony Ministry for the Environment, Energy and Climate Protection (MU) with funds from the water abstraction fee and the sovereign tasks in the area of fertiliser law are carried out by the Ministry of Food, Agriculture and Consumer Protection.

Landwirtschaftskammer Niedersachsen LBEG

Field trials on fertiliser law and water protection

Blue Book:
Calculation of compensation payments in accordance with §93 NWG

New notifications of the catalogue of measures

Publications

Trial reports, articles, guidelines

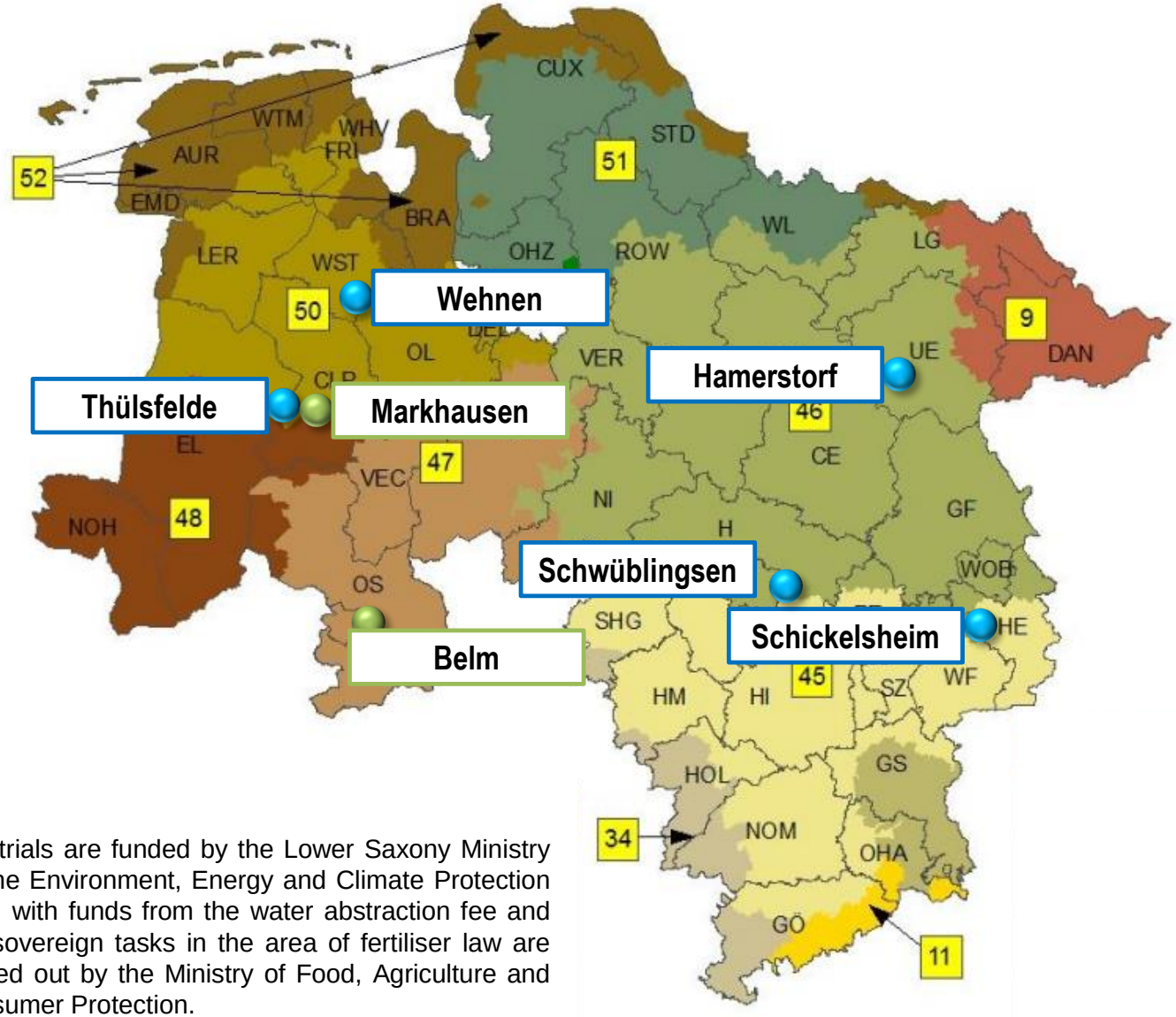
Events, information for co-operation

Field days

State-wide working group on water protection

Field trials for groundwater protection in Lower Saxony

Landwirtschaftskammer Niedersachsen
Düngebehörde



Leachate studies [8 dm soil depth]

LBEG Landesamt für Bergbau, Energie und Geologie
GEOZENTRUM HANNOVER

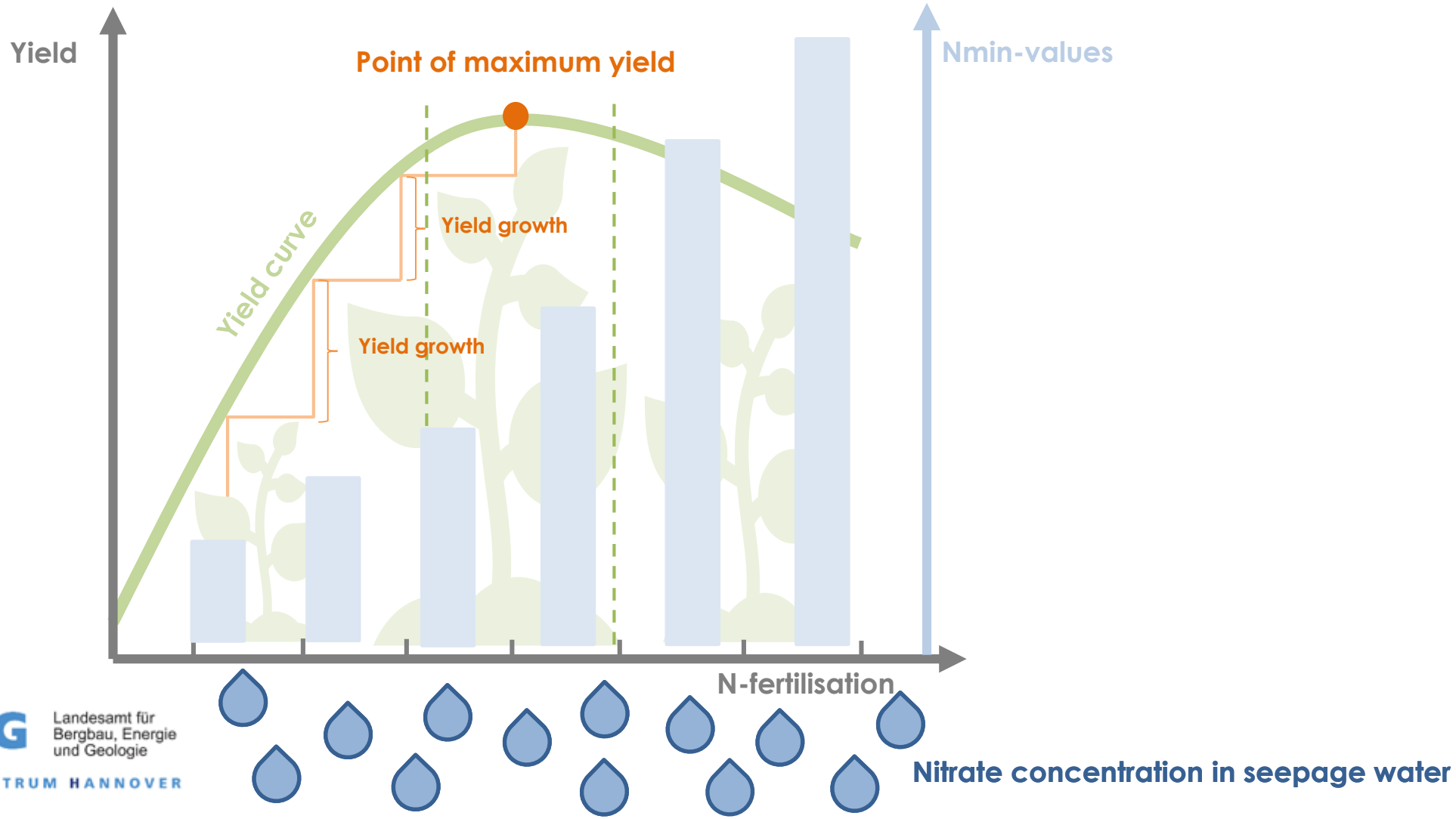
Other research institutes

BKR	Soil-climate-region	Site
50	Northwestern Weser-Ems-Region/ Sandy soils	**Wehnen, Thülsfelde und Markhausen**
46	Lüneburger Heide/ sandy soils	**Hamerstorf**
46	Eastern Weser-Region/ Sandy soils	**Schwüblingsen**
47	Middle of Lower Saxony/ Loamy soils	**Belm**
45	Südhannover/ Loamy soils / loess soils	**Schickelsheim**

The trials are funded by the Lower Saxony Ministry for the Environment, Energy and Climate Protection (MU) with funds from the water abstraction fee and the sovereign tasks in the area of fertiliser law are carried out by the Ministry of Food, Agriculture and Consumer Protection.

Law of Diminishing Returns,N_{min}-values, nitrate concentration in seepage water

Landwirtschaftskammer Niedersachsen
Düngebehörde



LBEG Landesamt für Bergbau, Energie und Geologie
GEOZENTRUM HANNOVER

Results from the Lower Saxony water protection trials with accompanying seepage water investigations § 28 NWG

Crop rotation period 2019-2021 at the Schickelsheim site

LWK: ***W. Klahsen*****, A. Knigge-Sievers, T. Eiler**

LBEG: **N. Bischoff, L. Noltemeyer, *A. Fier*, J. Wessels, K. Meyer**

15.11.2023

The trials are funded by the Lower Saxony Ministry for the Environment, Energy and Climate Protection (MU) from funds from the water abstraction charge and the sovereign tasks in the area of fertiliser law by the Ministry of Food, Agriculture and Consumer Protection.

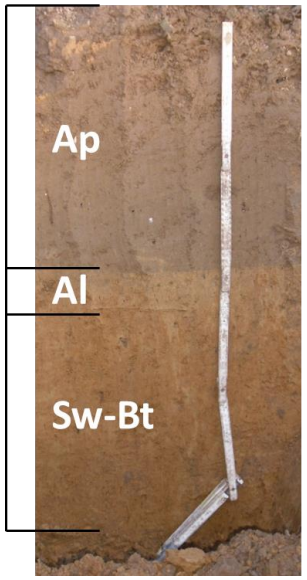
Schickelsheim test site

Landwirtschaftskammer Niedersachsen
Düngebehörde

Site description and experimental setup

- Soil type: Luvisol
- Loamy soil
- Arable land rating number: 79
- Characteristic values of the Ap horizon:

N_t [%]	C_{org} [%]	C/N-value	SOM [%]
0,12	1,1	9	1,9



Tiefe (cm)	Horizont	Textur	C_{org} (%)
0-39	Ap	Ut3	1,21
39-46	Al	Ut3	0,26
46-95	Sw-Bt	Ut4	0,16

Mean temperature: 9,9 °C

Mean precipitation: 615 mm

Effective rooting depth: 11 dm

FC_{We}: 373 mm

Trial questions at the Schickelsheim site (selection)

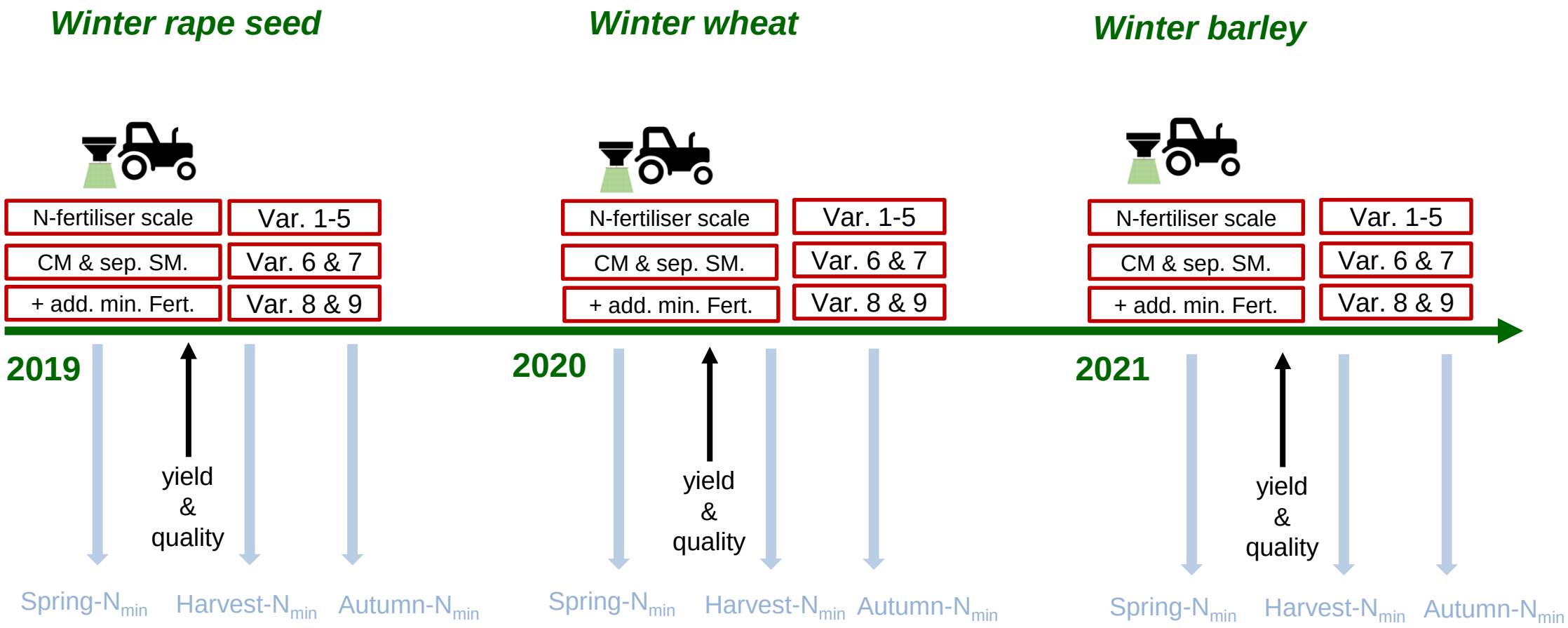
Landwirtschaftskammer Niedersachsen
Düngebehörde

How does the level of N fertilisation affect N dynamics in the soil, N leaching into the leachate, yields and quality parameters?

What influence does organic and organic-mineral N fertilisation have on the medium- and long-term N dynamics in the soil on sites fertilised for many years with mineral fertilisers?

Which N mineral fertiliser equivalents are to be used for farm manure in arable regions?

Data collection in the Schickelsheim field trial (Example: test block 1)

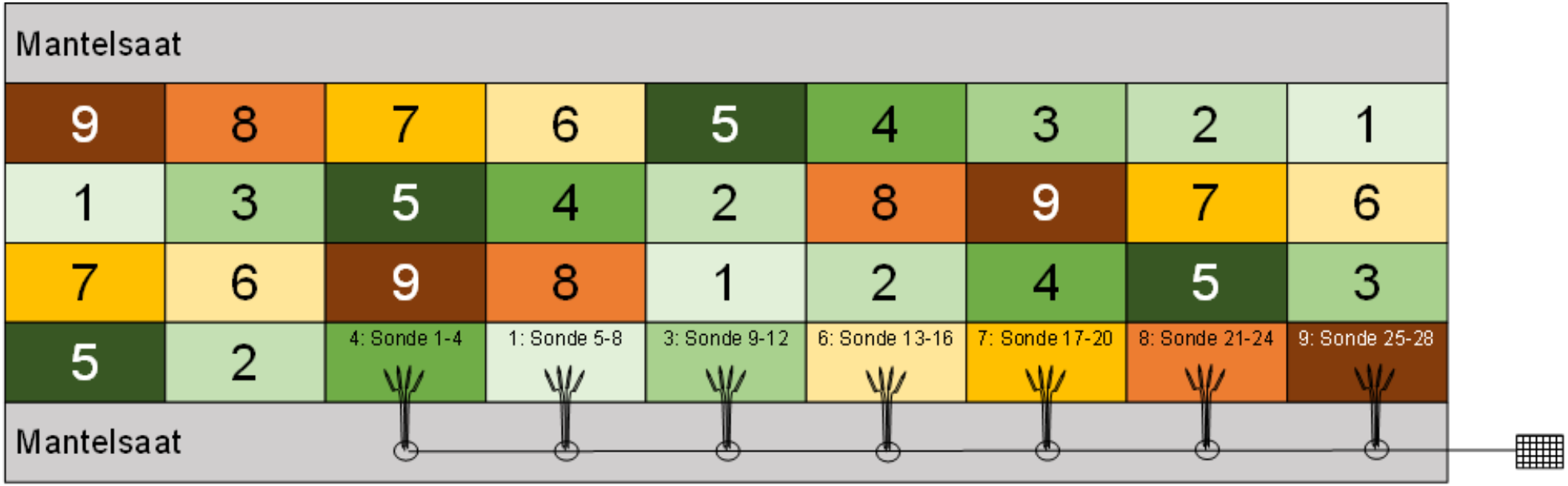


Experimental setup field trial Schickelsheim

Landwirtschaftskammer Niedersachsen
Düngebehörde

Düngung [kg N/ha]	Mineralische Düngestaffel					Hähnchenmist		Sep. Schweinegülle	
Variante	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
WRaps	0	60	120	180	240	6 t/ha	6t/ha + min. bis 180 kg N anr.	6 t/ha	6t/ha + min. bis 180 kg N anr.
WW	0	70	140	210	280	6 t/ha	6t/ha + min. bis 210 kg N anr.	6 t/ha	6t/ha + min. bis 210 kg N anr.
WG	0	60	120	180	240	6 t/ha	6t/ha + min. bis 180 kg N anr.	6 t/ha	6t/ha + min. bis 180 kg N anr.

Example Block 1:



Trial questions at the Schickelsheim site (selection)

Landwirtschaftskammer Niedersachsen
Düngebehörde

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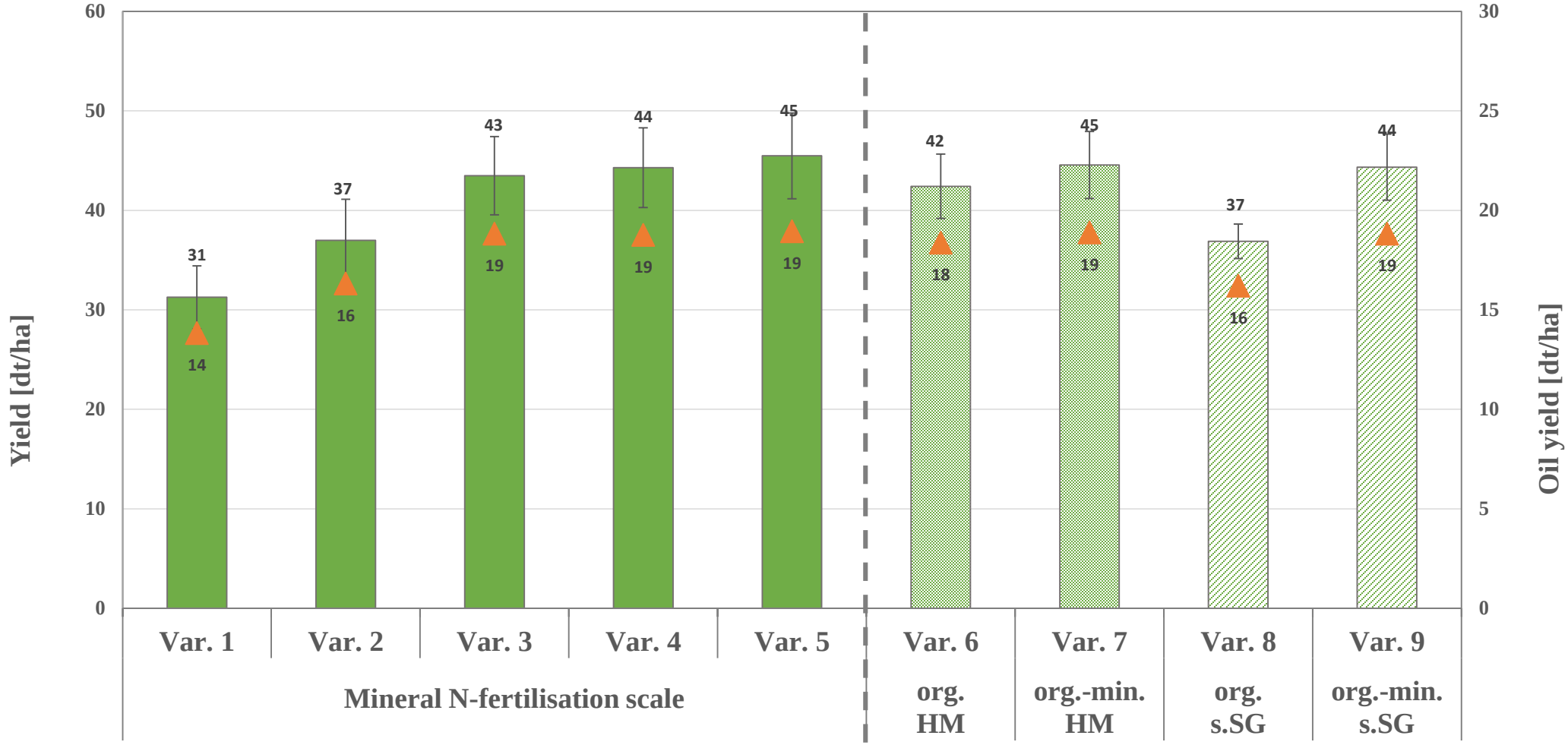
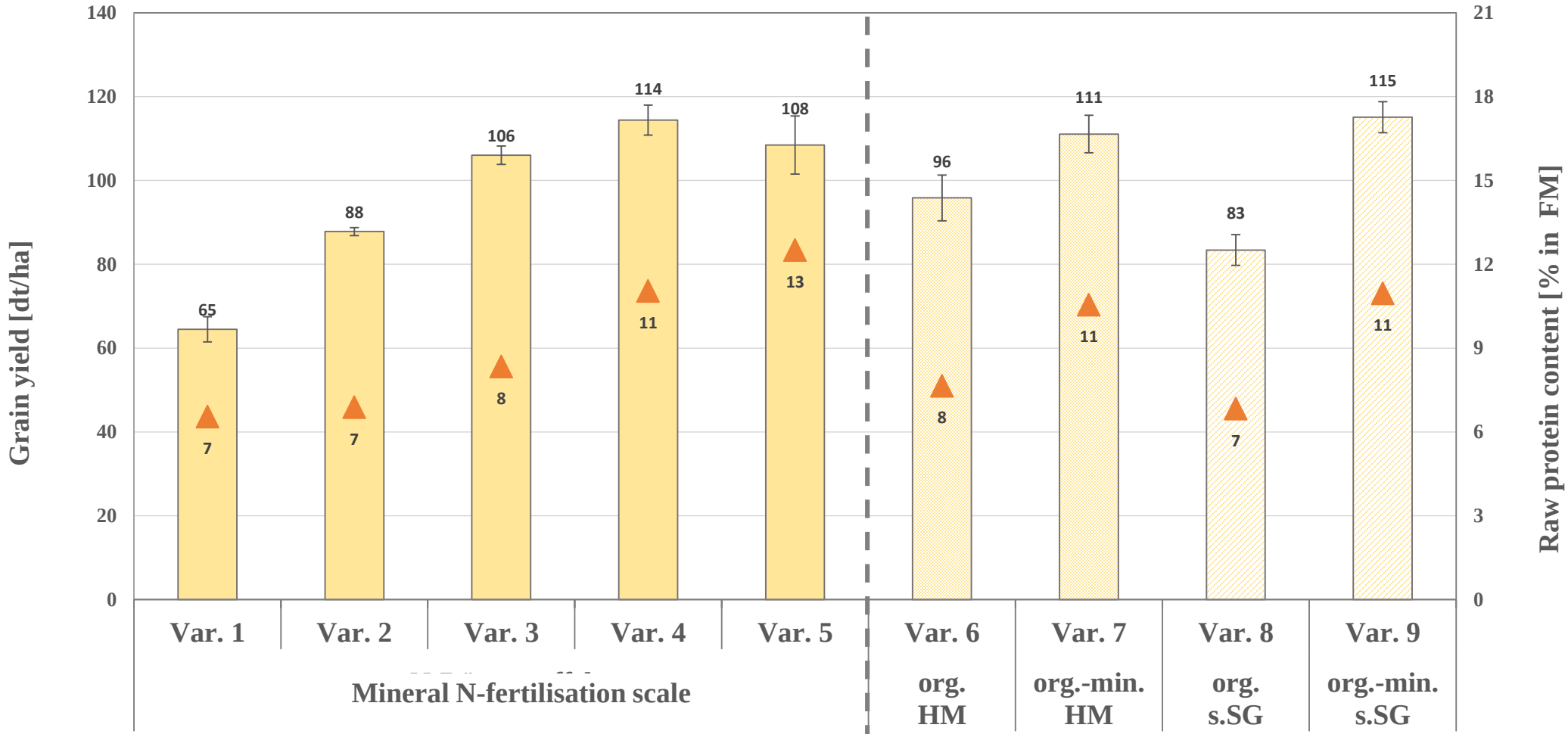
Yield & quality of winter rape seed on average over the years 2019-2021



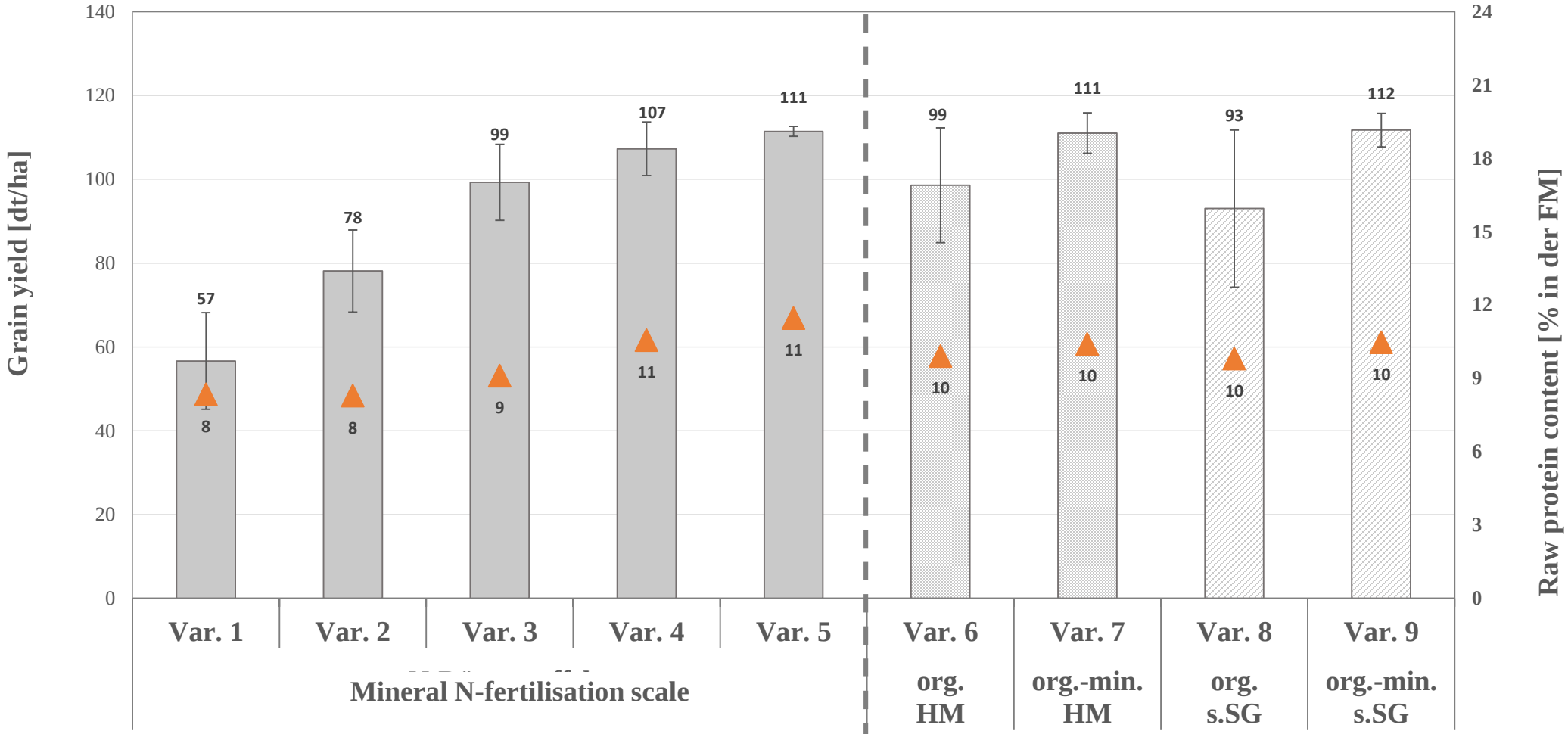
(min./org.)	(0/0)	(60/0)	(120/0)	(180/0)	(240/0)	(0/6)	(180/6)	(0/6)	(180/6)	(kg/ha/t/ha)
Spring-N_{min} on average over the years 2019-2021	(41)	(38)	(35)	(51)	(74)	(51)	(41)	(41)	(45)	(kg N /ha)
Harvest-N_{min} / autumn-N_{min} on average over the years 2019-2021	(46/80)	(50/92)	(57/95)	(83/128)	(125/152)	(60/122)	(96/138)	(47/96)	(90/140)	(kg N /ha)

Yield & quality of winterwheat on average over the years 2019-2021



(min./org.)	(0/0)	(60/0)	(120/0)	(180/0)	(240/0)	(0/6)	(180/6)	(0/6)	(180/6)	(kg/ha/t/ha)
Spring-N_{min} on average over the years 2019-2021	(47)	(57)	(68)	(74)	(107)	(73)	(77)	(57)	(79)	(kg N /ha)
Harvest-N_{min} / autumn-N_{min} on average over the years 2019-2021	(26/31)	(22/32)	(28/38)	(33/46)	(51/66)	(27/39)	(37/50)	(22/34)	(29/43)	(kg N /ha)

Yield & quality of winter barley on average over the years 2019-2021



(min./org.)	(0/0)	(60/0)	(120/0)	(180/0)	(240/0)	(0/6)	(180/6)	(0/6)	(180/6)	(kg/ha/t/ha)
Spring-N_{min} on average over the years 2019-2021	(26)	(26)	(33)	(34)	(54)	(29)	(33)	(25)	(37)	(kg N /ha)
Harvest-N_{min} / autumn-N_{min} on average over the years 2019-2021	(34/39)	(29/33)	(25/40)	(29/56)	(36/92)	(46/43)	(41/71)	(47/44)	(34/48)	(kg N /ha)

Versuchsfragen am Standort Schickelsheim

How does the level of N fertilisation affect N dynamics in the soil, N leaching into the leachate, yields and quality parameters?

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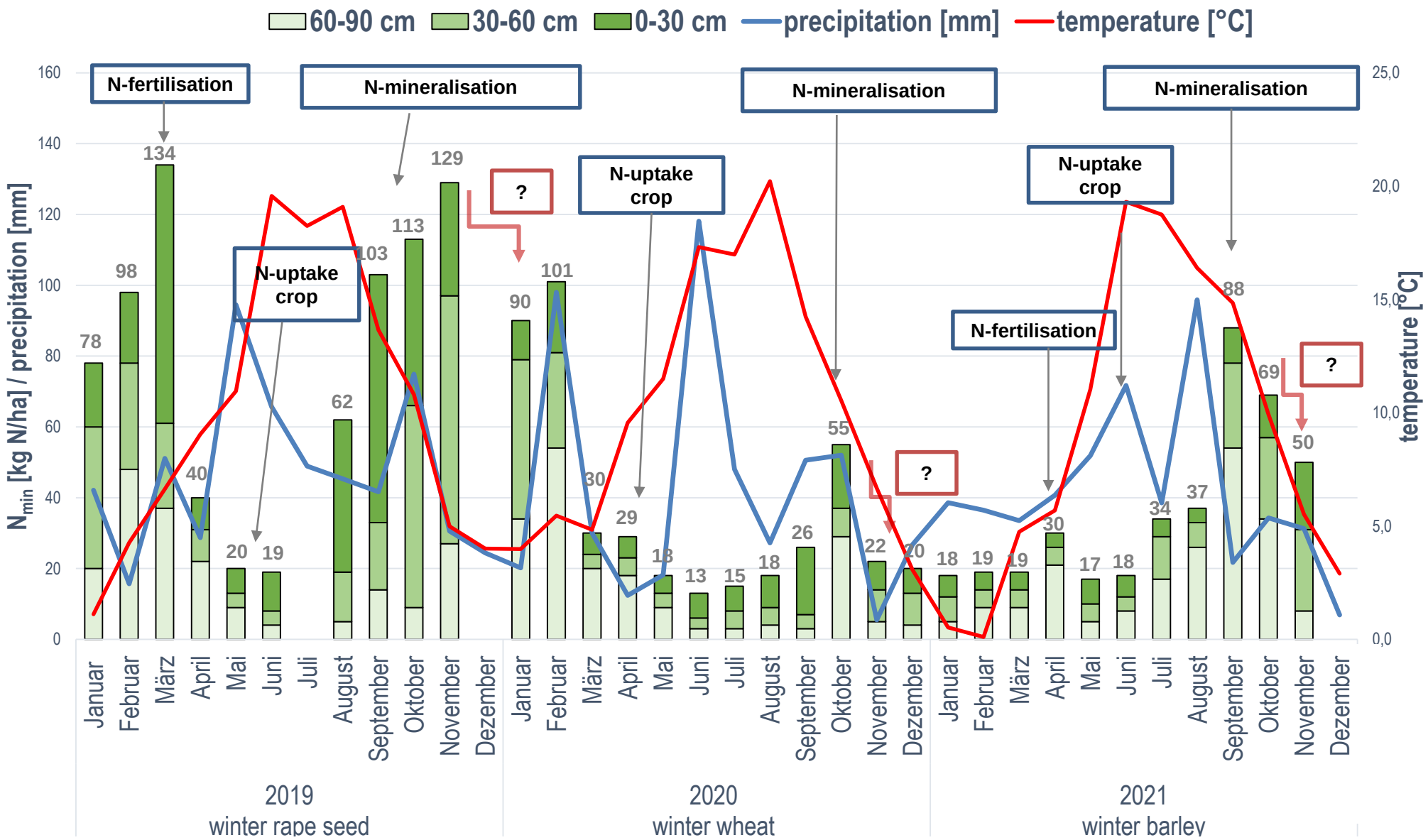
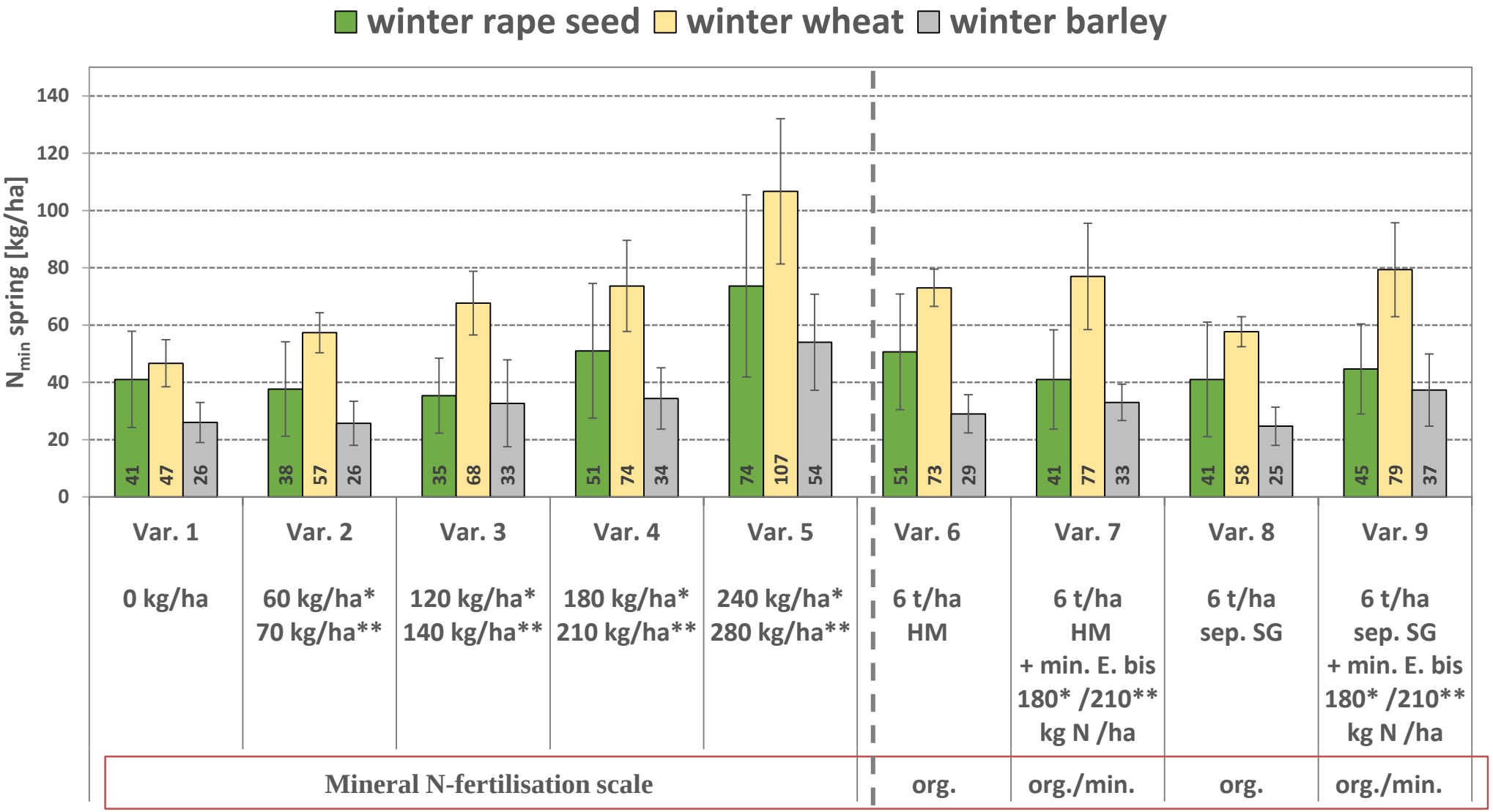
Monthly weather- and Nmin curve
Schickelsheim block 1 (2019 – 2021), „N-comparison variant“

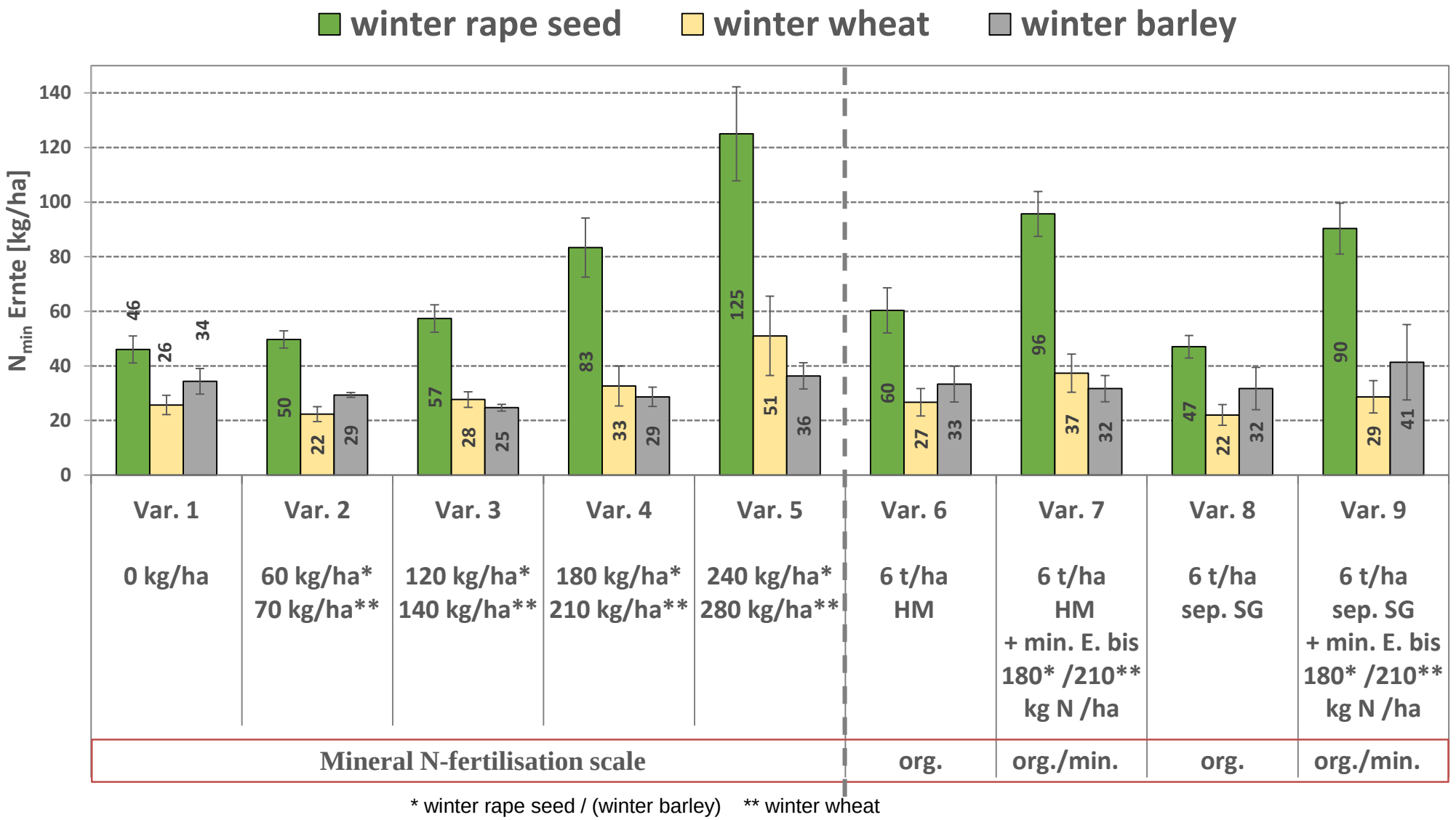


Spring-N_{min} to the respective crops on average ober the years 2019-2021



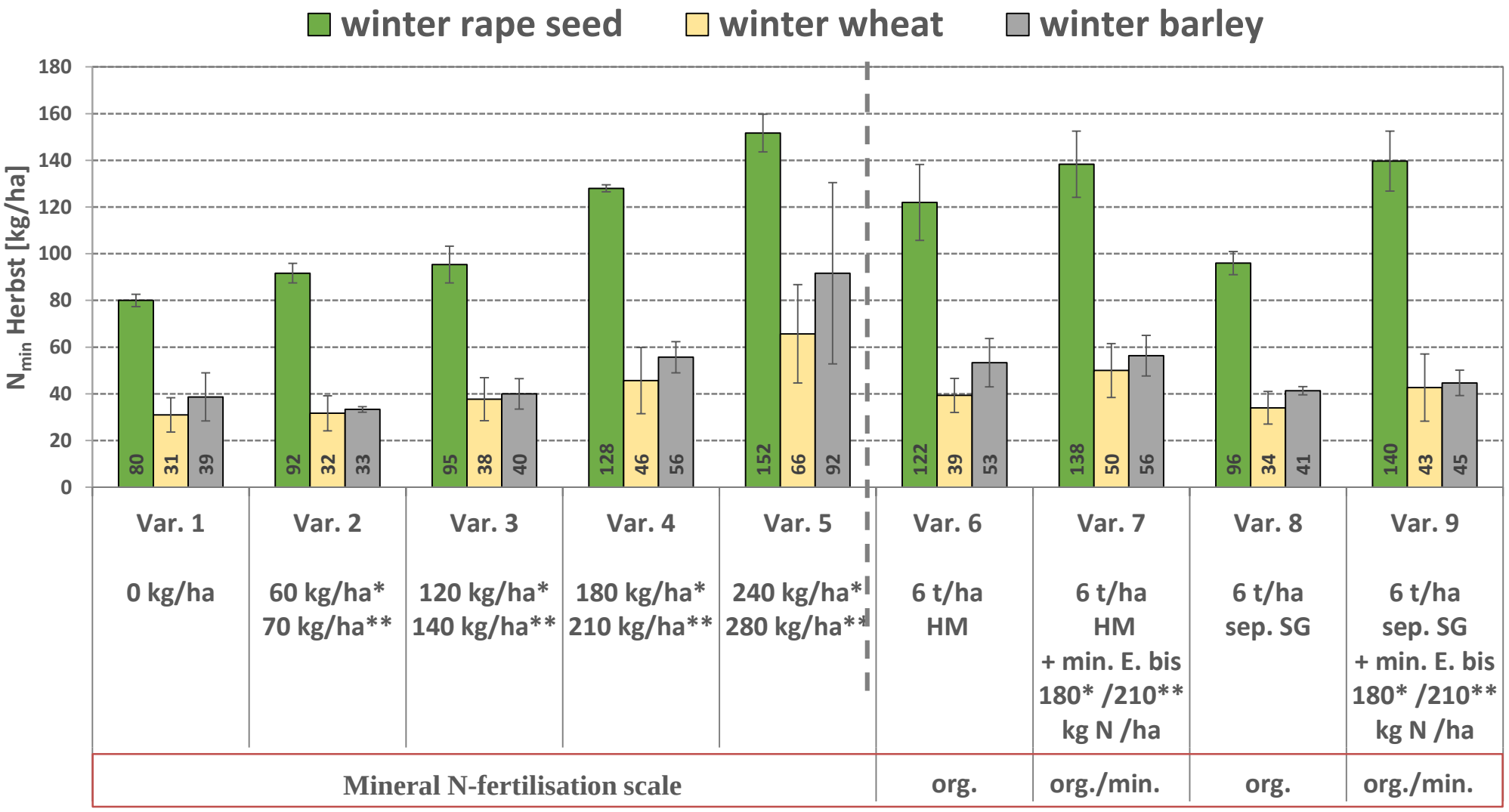
* winter rape seed / (winter barley) ** winter wheat

Harvest-N_{min} to the respective crops on average ober the years 2019-2021



* winter rape seed / (winter barley) ** winter wheat

Autumn-N_{min} to the respective crops on average ober the years 2019-2021



* winter rape seed / (winter barley) ** winter wheat

Versuchsfragen am Standort Schickelsheim

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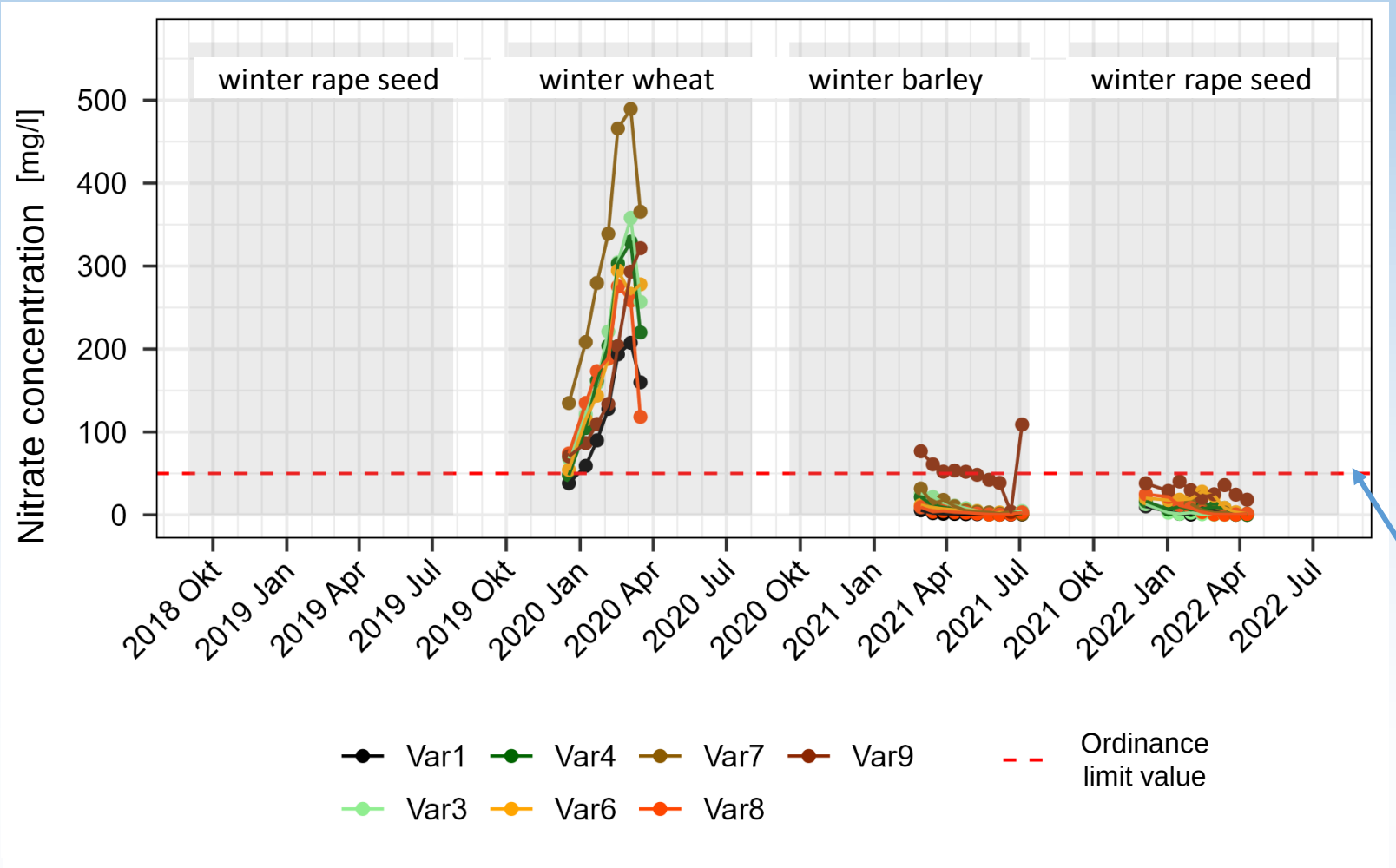
Soil water balance 2018 – 2022

Modelled seepage water quantity below the effective rooting depth

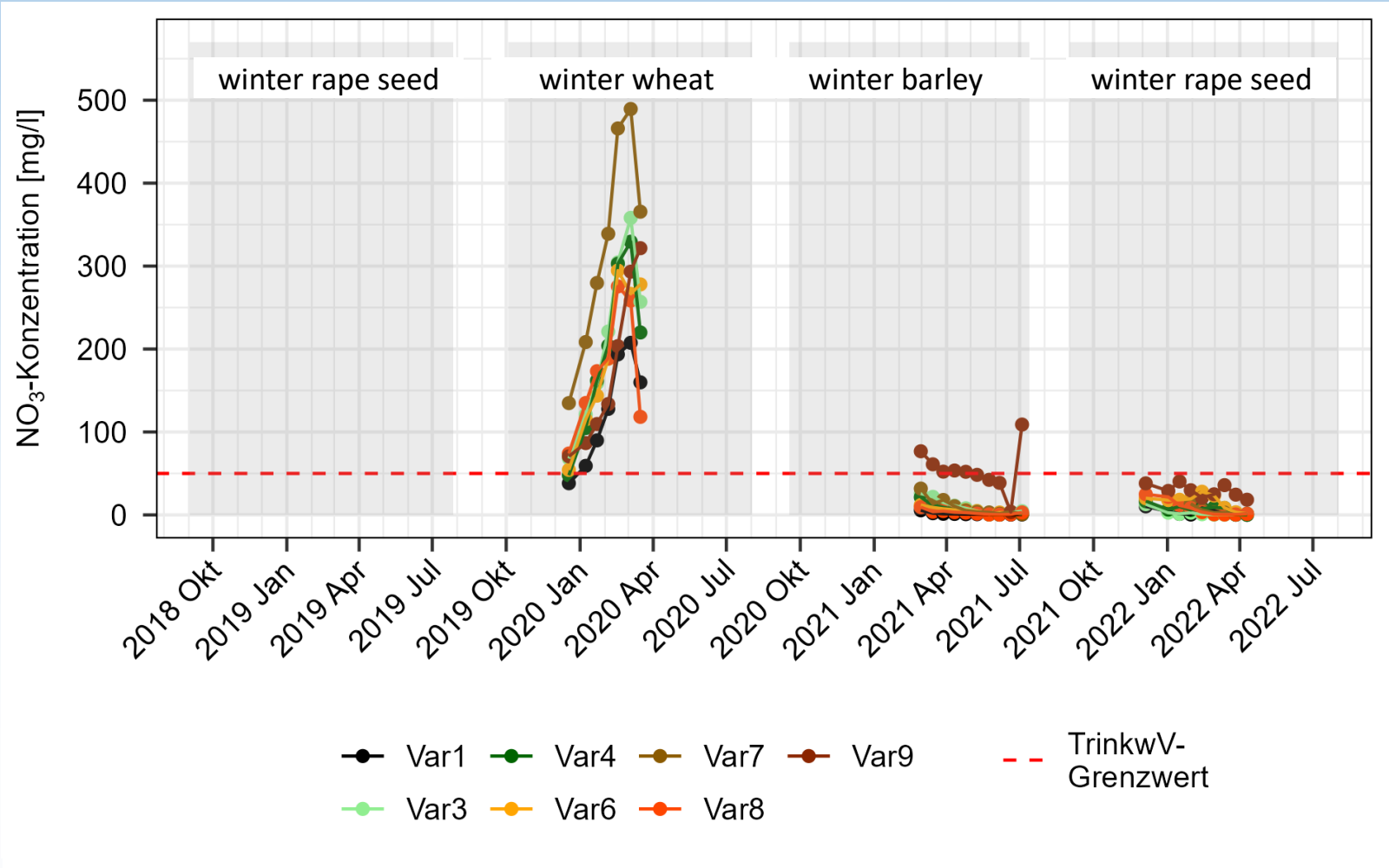
Measured nitrate concentration in the leachate



Var1	0 kg N/ha (mineral N)
Var3	120/140 kg N/ha (min.)
Var4	180/210 kg Nha (min.)
Var6	6t HM
Var7	6t HM + min. up to 180/210 kg N/ha creditable-N
Var8	6t sep. SG
Var9	6t sep. SG + min. up to 180/210 kg N creditable-N

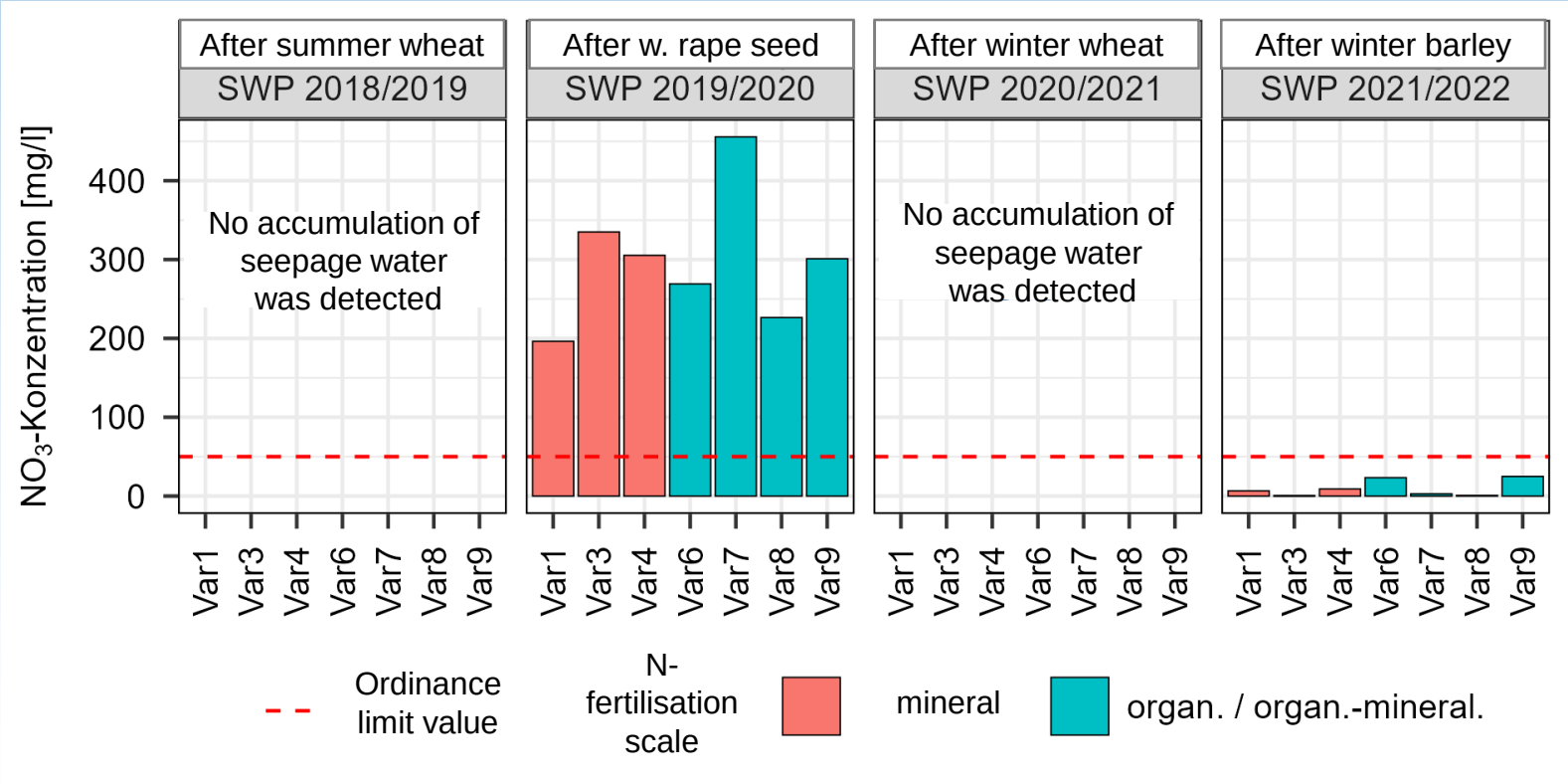
Drinking water protection ordinance limit value for orientation purposes

Measured nitrate concentration in the leachate



- **Nach Raps** erhöhte NO_3-Konzentrationen (> 50 mg/l) unter allen Varianten. Ursache: viele leicht mineralisierbare Pflanzen- und Ernterückstände + Stoppelbearbeitung
- **Nach Getreide** deutlich geringere NO_3-Konzentrationen
- Effekt der vorherigen Hauptkultur größer als Effekt der N-Düngung

Mean nitrate-concentration



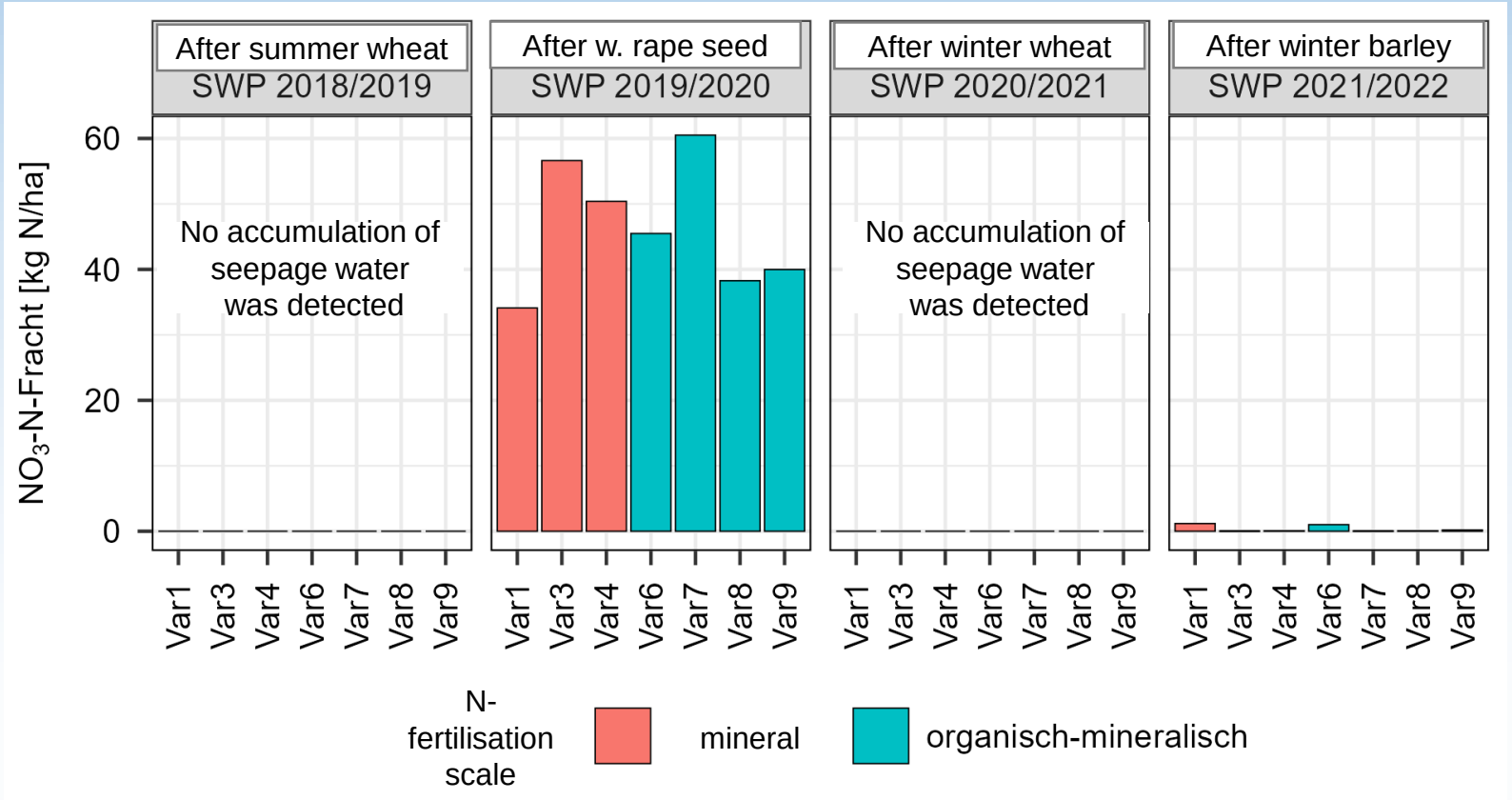
After winter rape seed:

- Var. 7, organic-mineral Fertilisation with Chicken manure, 180 kg N/ha (creditable), tends to have the highest N-concentration

After winterbarley:

- Differences between the variants at a comparatively low level

Nitrate-N-load



<u>After winter rape seed (frequency of the exchange Ø 0,2):</u>

- Nitrate-N-loads between 35 – 60 kg/ha
- Reduced mineral N fertilisation (Var3 vs. Var4) has not yet led to a lower N load
- The variant with chicken manure tends to have slightly higher N yields than the variant with separate pig manure

<u>After winter barley (frequency of the exchange Ø 0,06):</u>

- Nitrate-N-loads of max. 1 kg/ha
- Low measured concentrations in combination with low leachate quantities lead to a very low N load

Versuchsfragen am Standort Schickelsheim

Landwirtschaftskammer Niedersachsen

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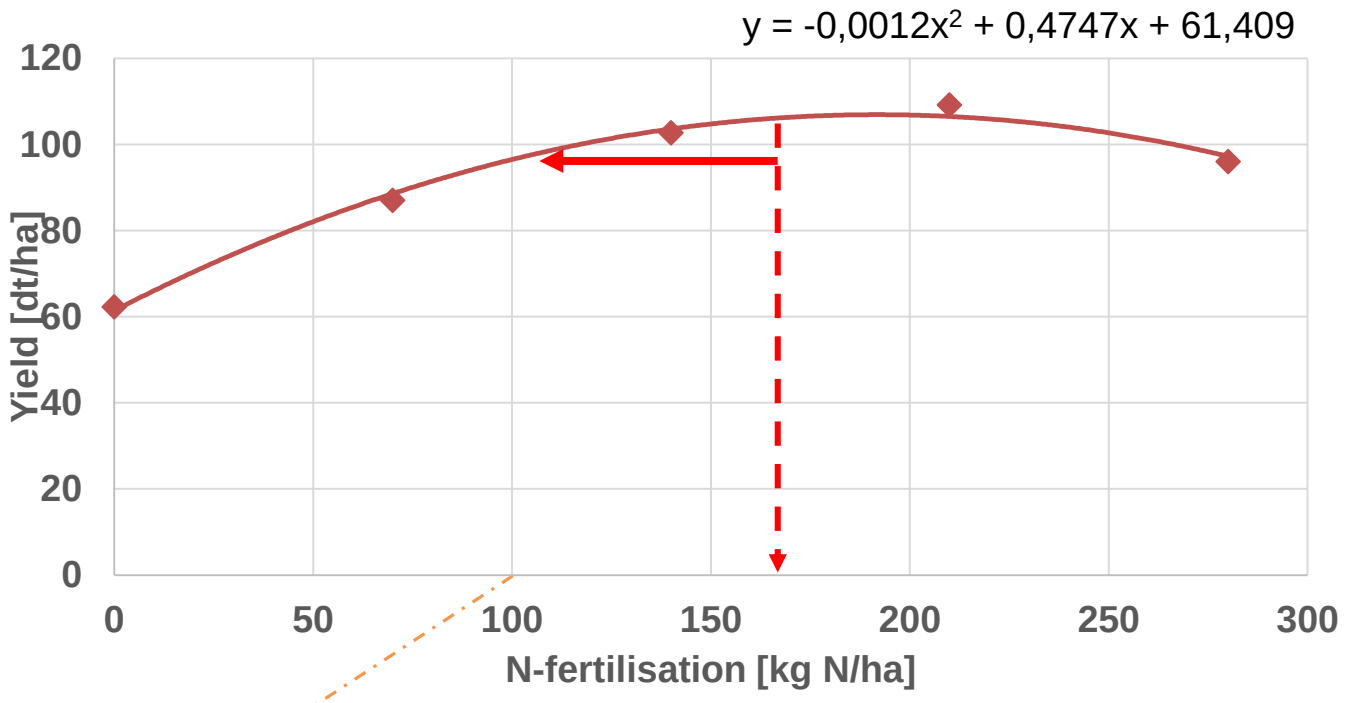
Calculation of mineral N-fertiliser equivalents (N-MDÄ)

N mineral fertiliser equivalents refer to the yield effect. They indicate how slurry N works in comparison to mineral fertiliser N.
(Def. Koriath et al., 1975)



N-MDÄ = $\frac{\text{N kg/ha mineral fertiliser}}{\text{N kg/ha organic fertiliser}} \times 100$

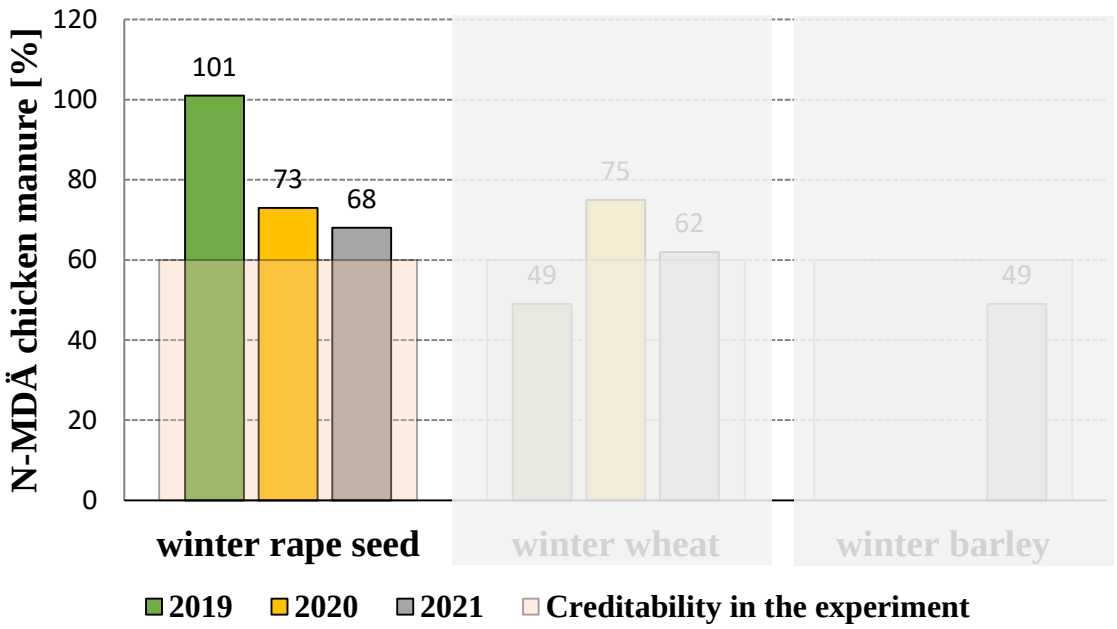
N-MDÄ = $\frac{100}{162} \times 100$

N-MDÄ = 62 %

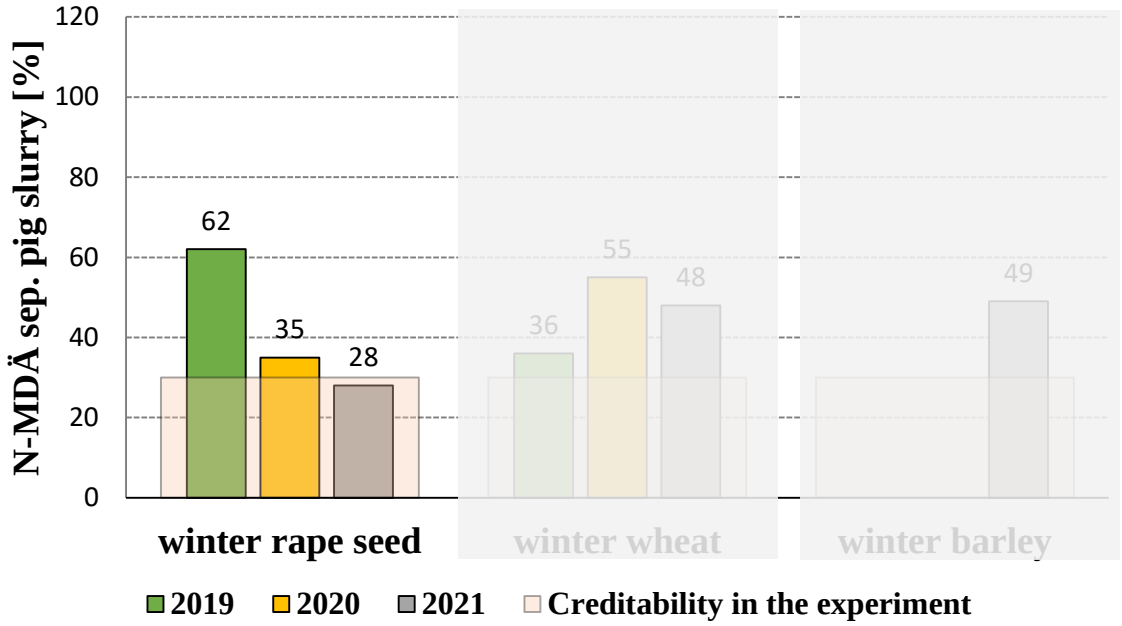
? 162 kg chicken manure N/ha give the same yield as 100 kg N/ha from mineral fertiliser

Mineral N-fertiliser equivalents (N-MDÄ) of the respective crops 2019-2021

Chicken manure



Separated pig slurry



Nutrient content of processed farm manure in Schickelsheim

Landwirtschaftskammer Niedersachsen
Düngebehörde

	2018		2019		2020		2021	
Results of analyses	HTK	Sep. pig manure	Chicken manure	Sep. pig manure	Chicken manure	Sep. pig manure	Chicken manure	Sep. pig manure
Dry matter	65,5 %	25,9 %	45,1 %	27,4 %	52,6 %	24,3 %	48,6 %	28,4 %
Total nitrogen (N)	**33 kg/t**	**10,7 kg/t**	**26 kg/t**	**10,4 kg/t**	**24,8 kg/t**	**6,7 kg/t**	**27 kg/t**	**8,8 kg/t**
Ammonium-nitrogen (NH_4-N)	3,6 kg/t	3,1 kg/t	4,6 kg/t	3,5 kg/t	4,0 kg/t	2,0 kg/t	2,8 kg/t	4,7 kg/t
Phosphorus (P_2O_5)	**11,4 kg/t**	**19,2 kg/t**	**11,0 kg/t**	**14,4 kg/t**	**8,6 kg/t**	**10,3 kg/t**	**7,41 kg/t**	**22,3 kg/t**

Versuchsfragen am Standort Schickelsheim

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Interim conclusion after completion of the first crop rotation period 2019-2021

Experimental question 1)
Influence on N-dynamics in the soil, yield and quality parameters

- org. - min. fertilised variants 7 & 9 at high yield and quality level (like "N comparison variant")

1

- Spring Nmin, harvest Nmin and autumn Nmin values after winter rape seed significantly higher than after cereals

- High N leaching, especially after winter oilseed rape → **Need for action to improve water protection**

Experimental question 2)
Influence of org./org.-min. fertilisation on N dynamics at the Schickelsheim site

- Tendency towards higher leaching risk after organic-organic mineral fertilization

- Does needs-based organic/organic-mineral fertilisation lead to increased Nmin values in the soil compared to mineral N fertilisation?

→ **Further observations necessary**

- Long-term influences on N dynamics → **Further crop rotation cycles necessary**

Experimental question 3)
Which N-MDA of farm fertilisers should be used in arable farming regions?

- The use of farm manure at the Schickelsheim site is worthwhile

- N-MDAs are influenced by the type of cultivation, location, annual weather conditions and crop type

- The values of the fertilizer ordinance represent a minimum value for creditability

N-Fertilisation and Intercropping: Effects on Nitrate leaching

Results from field trials in Lower Saxony, Germany

15th of November 2023
Fertilisation Authority of Lower-Saxony
Wolfgang Klahsen

The trials are funded by the Lower Saxony Ministry for the Environment, Energy and Climate Protection (MU) from funds from the water abstraction charge and the sovereign tasks in the area of fertiliser law by the Ministry of Food, Agriculture and Consumer Protection.

Field trial 645 in Wehnen: Site characterisation

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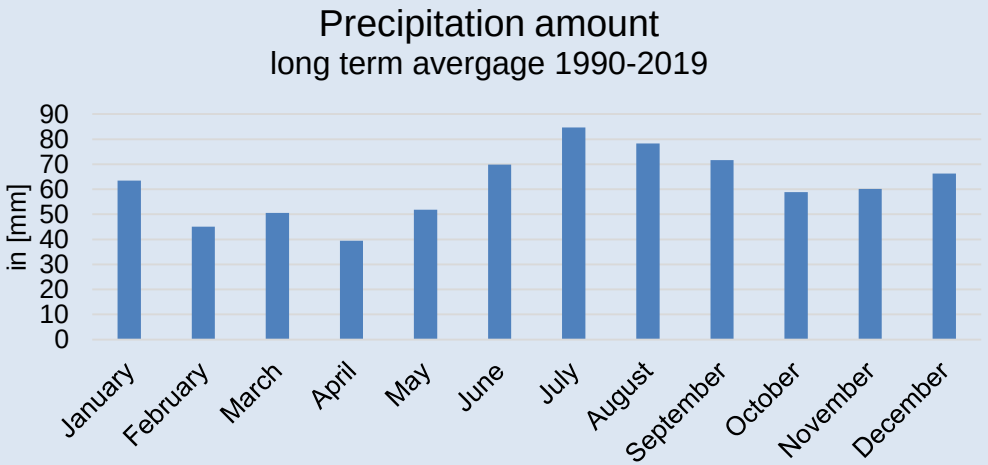
- Annual Precipitation: 771 (592-895 mm/year)
- Medium seepage water: 347 mm/year (>1)
- Temperature: 10,0 °C



- Soil classification: Plaggic anthrosol; *WRB: Anthrosol*
- Soil type: Sandy soil (with high content of organic matter)
- Characteristic values of the A_p-Horizon:

0-30 cm	A_p
30-40 cm	E
40-50 cm	B_{hs}
50-60 cm	B_s
60-80 cm	C_v

N_t [%]	C_{org} [%]	C/N-ratio	Content OM [%]
0,12	2,0	17	3,1

Data sampling at the field trial in Wehnen

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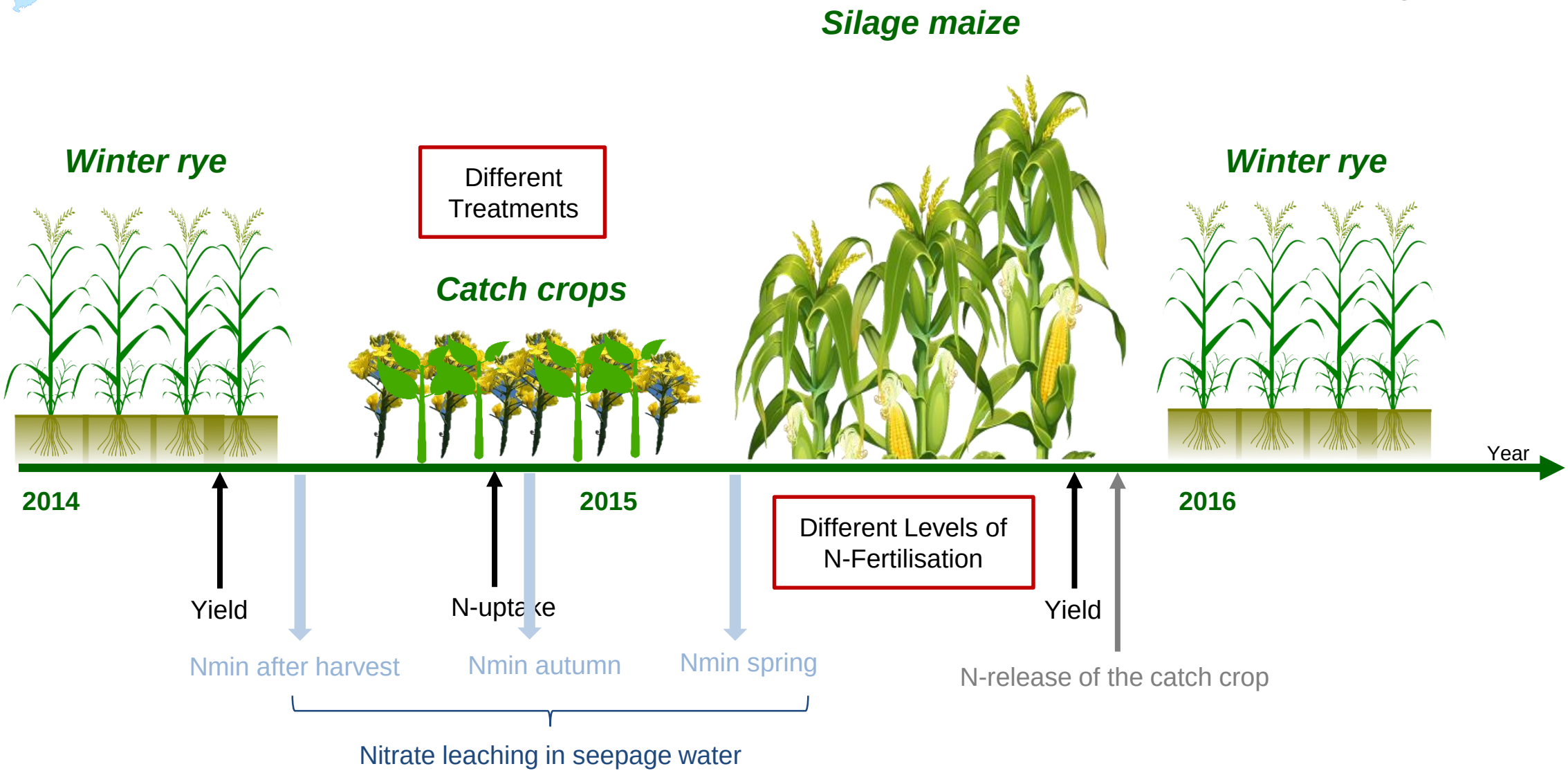

Fertilisation and catch crop treatment of the field trial in Wehnen

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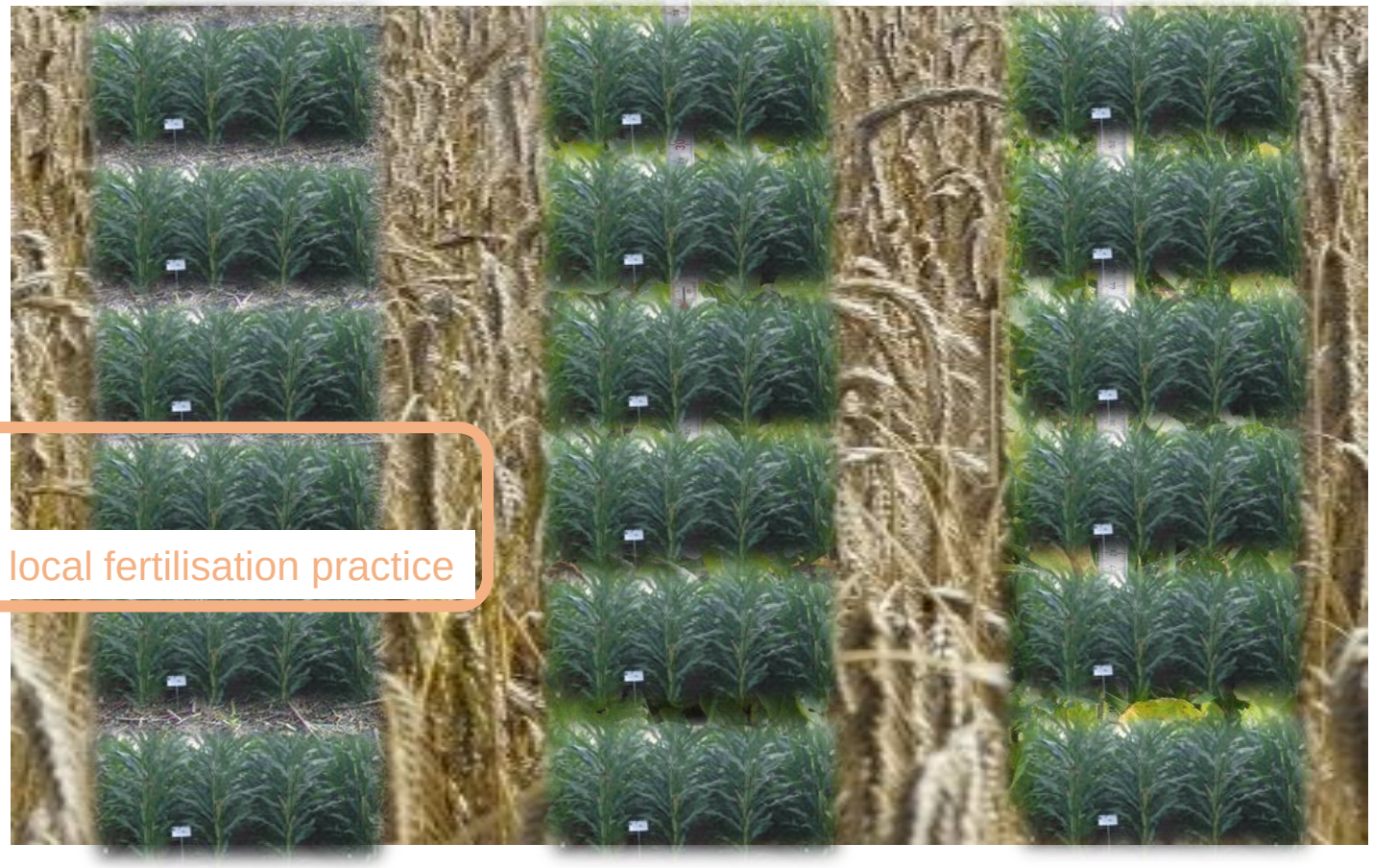
Nitrate concentration in seepage water (80 cm depth)

LBEG Landesamt für Bergbau, Energie und Geologie
GEOZENTRUM HANNOVER

0 kg N/ha
60 kg N/ha
120 kg N/ha
180 kg N/ha
240 kg N/ha
300 kg N/ha

control representing the local fertilisation practice

Without Catch crop	Non-hardy unfertilised Catch crop*	Non-hardy organically-fertilised Catch crop*



*Catch crop (mustard& radish)

Yield of silage maize (without CC) and N_{min}-values (2012 - 2020)

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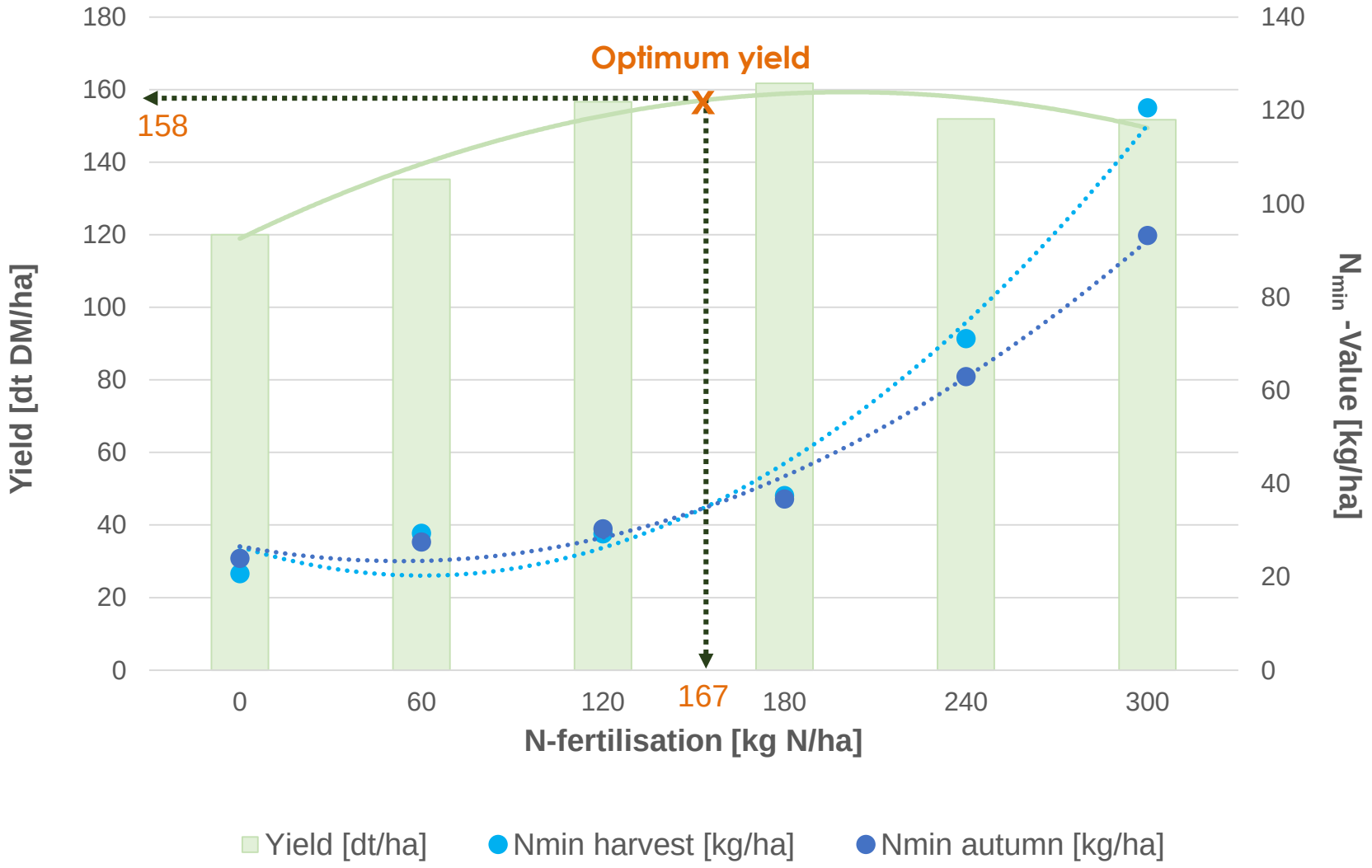

Dry matter yield of the catch crop, temperature and precipitation 2013 & 2014

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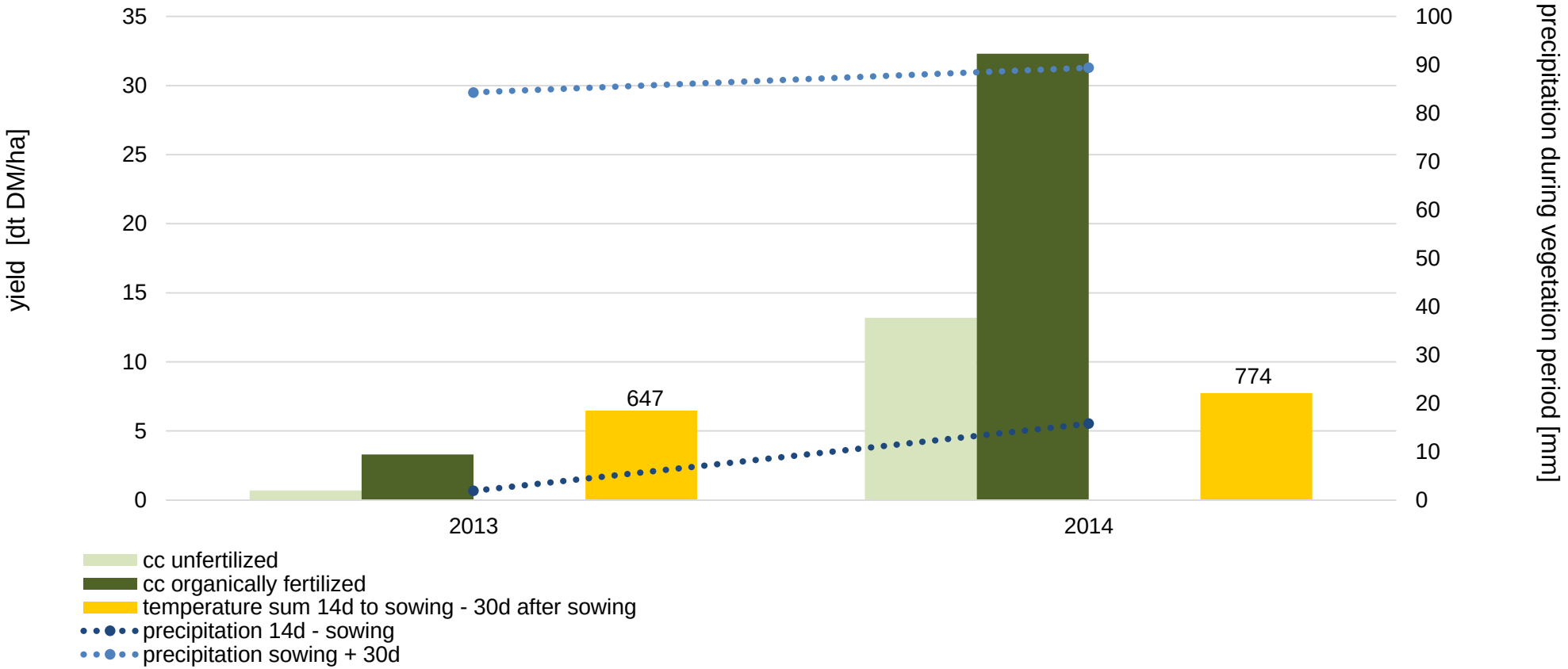
sowing: 03.09.2013 04.08.2014



N-release of the catch crop (unfertilised and organically fertilised) calculated with the optimum yield of the subsequent silage maize

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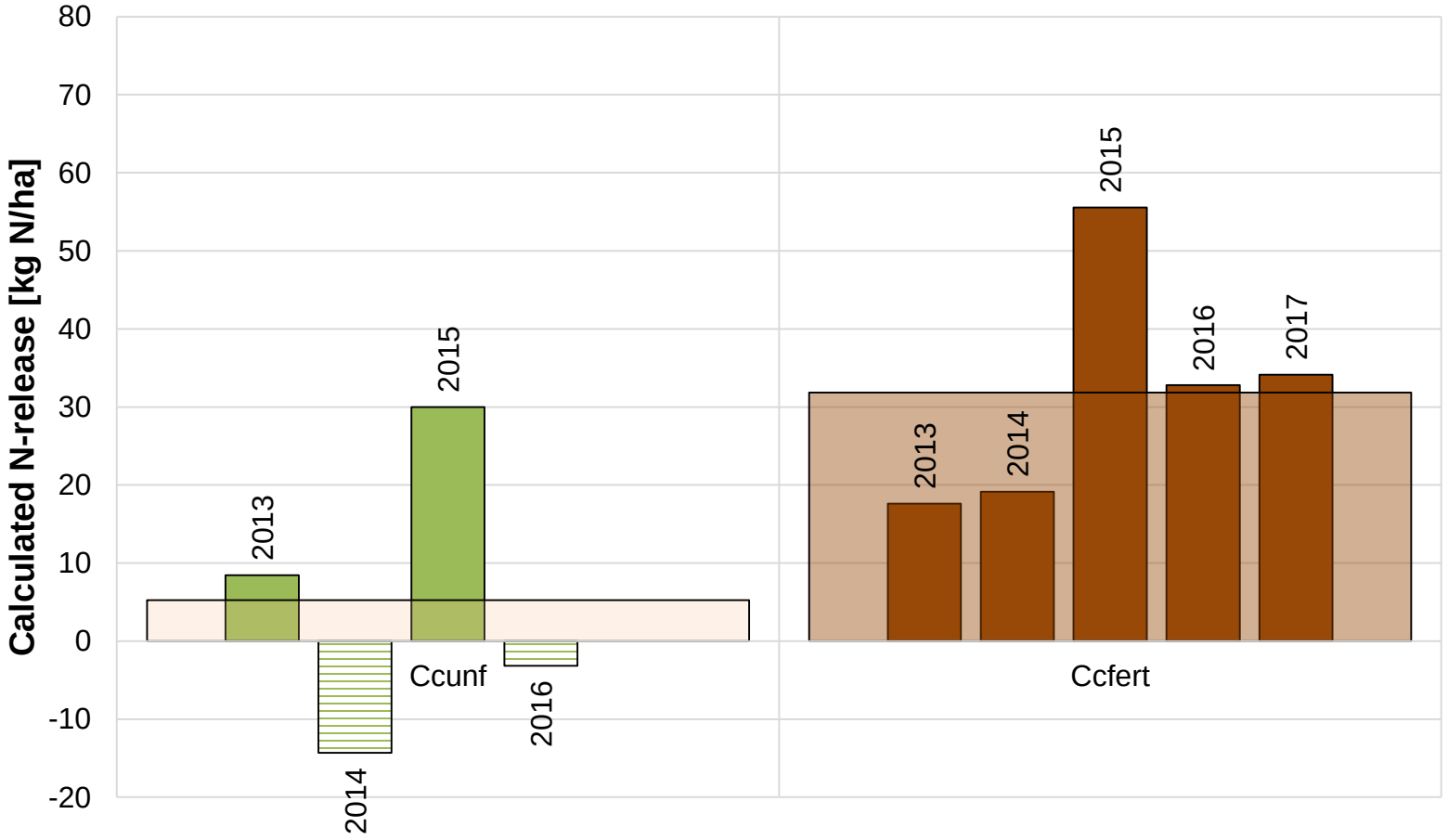
CC unfertilised: Average 5 kg N/ha

CC organically fertilised: Average 31 kg N/ha



Autumn Nmin values after winter rye and with catch crops Ø 2012 - 2017

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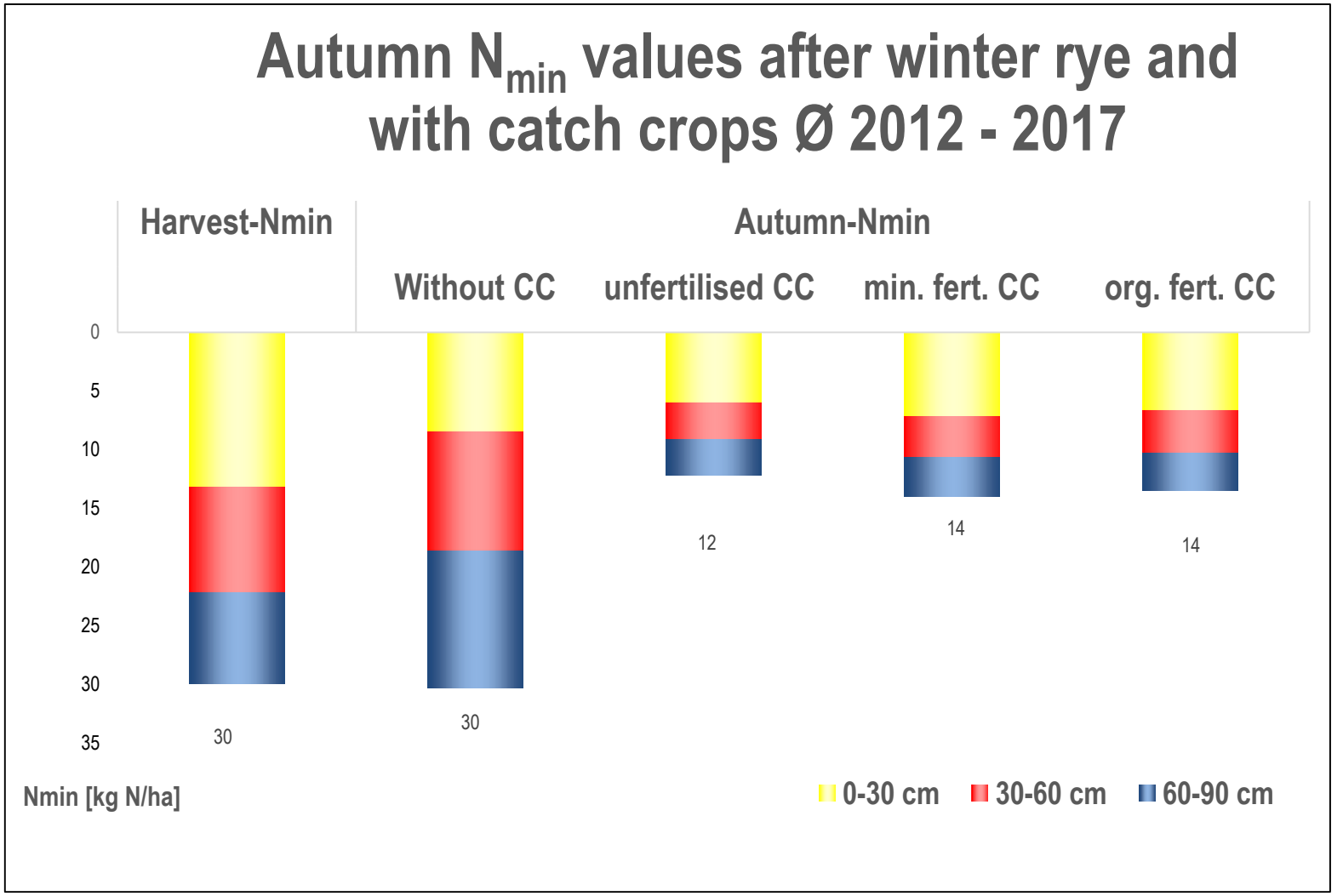

Nitrate leaching in seepage water (80 cm depth)

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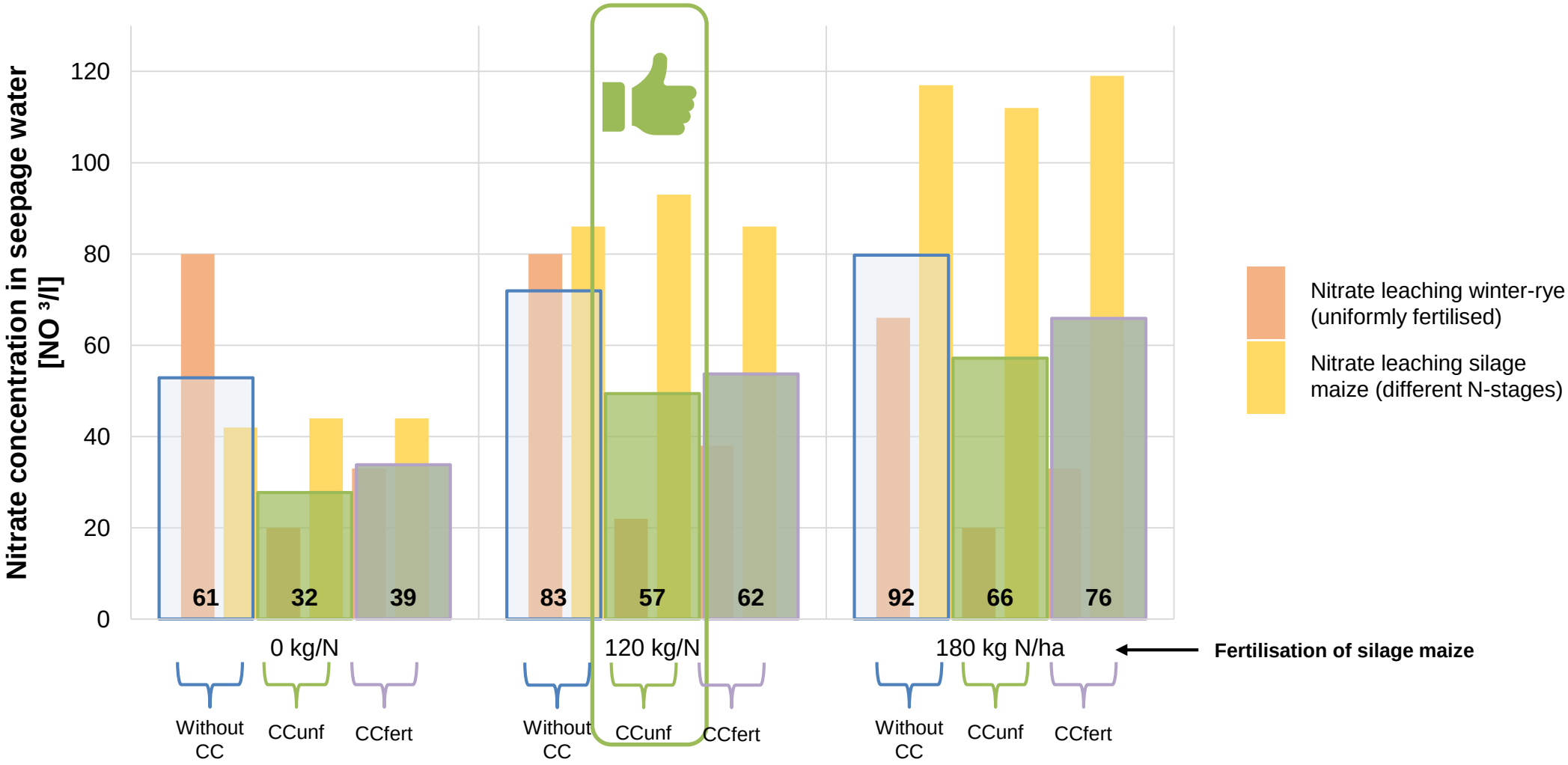

Positive effects on nitrate leaching by…

…reducing N-fertilisation in silage maize

- **lowers N_{min}-values and NO_3 –leaching.**
- On the contrary: N-surplus (> 180 kg N/ha) increases nitrogen in soil and leachate **exponentially**.

…growing catch crops

- **reduces N_{min}-values and NO_3 leaching** (compared bare fallow land).
- the N-release of the CC residue has to be taken into account & the subsequent fertilisation has to be adjusted.

…combining the effects

- CC & reduced fertilisation of silage maize (120 kg N/ha) **reduces N-leachate significantly** (57/62 ppm) nearly **without yield loss** (99%)!

→ Further research is needed in order to investigate further interactions of the N-cycle for precise forecast of the N-release
→ and (longterm) effects on soil characteristics.

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Crop rotation and N-fertilization

…...offer a variety of possibilities for the realisation of groundwater protection-oriented land management...

Consistent intercropping reduces the residual Nmin content in the soil and nitrate losses in the leachate. Pay attention to the N supply of the following crop

Against this background, wide crop rotations with optimised intercropping (early sowing) should be aimed for.

In contrast to cereals, the reduced nitrogen fertilisation of silage maize significantly lowers the residual Nmin content in the soil.

Possibilities

- Success-honoured measures - e.g. low residual Nmin levels in the soil after silage maize - are a good approach for water protection
- Effective water protection measures (e.g. crop rotation) must be covered by the financial framework of the co-operations
- Stronger anchoring of the topic of fertilisation and water protection in agricultural training

It is important to ensure compliance with the N requirement approach at farm level as a starting point for further measures

- Operational farm contexts restrict the implementation of water protection measures
- Silage maize cultivation results in nitrate discharge despite a negative N balance.

limits

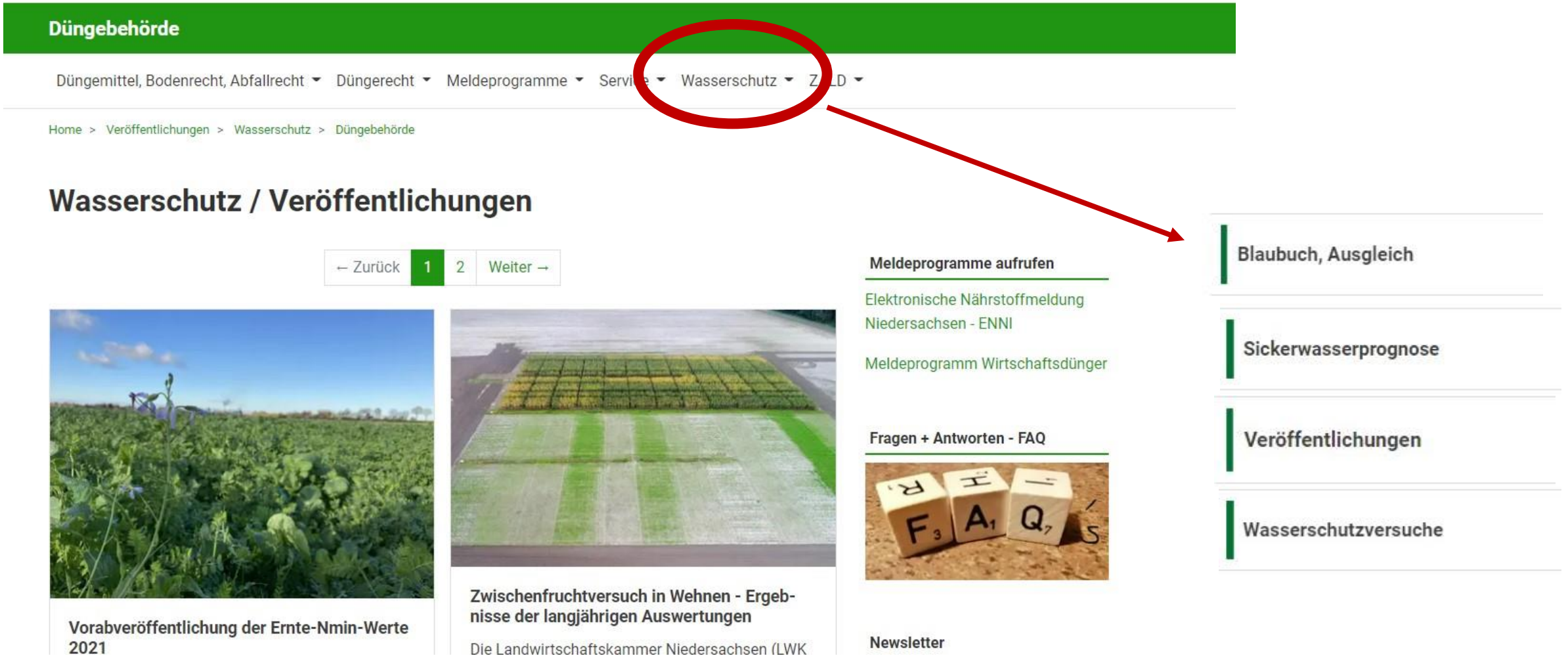
Presentation of the results of the success controls in the drinking water protection co-operations in Lower Saxony, Volume 34 of the Lower Saxony State Office for Water Management, Coastal Defence and Nature Conservation

NLWKN

Further information (in german)

Landwirtschaftskammer Niedersachsen

www.duengebehoerde-niedersachsen.de





Vielen Dank für Ihre Aufmerksamkeit!